

THE ILLUMINATING ENGINEER

LIGHT  
LAMPS  
FITTINGS  
AND  
ILLUMINATION

# THE JOURNAL OF GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by  
**LEON GASTER**

OIL  
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ELECTRICITY  
ACETYLENE  
PETROL-AIR  
GAS  
ETC.

Vol. XX

January, 1927

Price NINEPENCE

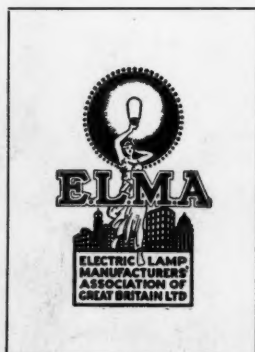
Subscription 10/6 per annum, post free  
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Progress in Illuminating Engineering during 1926—The Relation between Illumination and Fine Work (Typesetting by Hand)—Floodlighting—Light and Speed—Street Lighting and Public Safety—The Lighting of a Tennis Court—A Half Century of Artificial Lighting—News from Abroad, etc.

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<div style="display: flex; justify-content: space-between;"> <div style="width: 30%; border: 1px solid black; padding: 5px; text-align: center;"> <b>LIGHT LAMPS FITTINGS AND ILLUMINATION</b> </div> <div style="width: 30%; border: 1px solid black; padding: 5px; text-align: center;"> <b>OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.</b> </div> </div>
<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <b>Vol. XX</b> </div> <div style="width: 30%;"> <b>January, 1927</b> </div> <div style="width: 30%; text-align: right;"> <b>Price NINEPENCE</b>  <small>Subscription 10/6 per annum, post free. For Foreign Countries, 15/- per annum.</small> </div> </div>
<b>EDITORIAL AND PUBLISHING OFFICES:</b> <b>32 VICTORIA STREET, LONDON, S.W. 1.</b> <b>Tel. No.: Victoria 5215</b>

## Progress in Illuminating Engineering During 1926

WITH this issue *The Illuminating Engineer* commences its third year in its enlarged and revised form. We think that this extension, facilitating the inclusion of more matter of a popular character, besides allowing more space for the *Transactions* of the Illuminating Engineering Society and technical articles, has met with general approval. During the past year further progress has been made towards the formation of international connections. Naturally the organization of resources in this direction takes time, but we hope during the forthcoming year to advance further still towards the goal of rendering the journal a centre for information on illumination from all parts of the world.

It is customary at the beginning of a new year to review briefly past progress. The reports presented at the opening meeting of the Illuminating Engineering Society in October last served to show that the past year has been one of exceptional activity. The series of papers and discussions before the Society were exceptionally varied and informative. In addition there has been a number of gatherings at which illuminating engineering took a prominent place. In our May issue we gave a special account of the Optical Convention, which deservedly attracted much attention in the British press, besides being widely commented upon abroad. This was a very happy instance of the combination of conferences of experts and popular demonstrations. Whilst the proceedings naturally dealt primarily with optics, there were a number of papers dealing with various aspects of illuminating engineering, and many others in which the opportunities for co-operation between the optical expert and the illuminating engineer were well illustrated. At the conference of the Institution of Public Lighting Engineers, held in Newcastle during September 14-16th, an opportunity was provided of emphasizing the importance of street lighting, and at the Public Safety Conference held in London in October the close relation between street lighting and public safety was again emphasized. On this occasion reference was also made to the growing use of luminous signals and signs for the guidance of street traffic—a subject which has likewise attracted much attention abroad.

The Institution of Electrical Engineers paid special recognition to the importance of illuminating engineering by inviting Mr. A. P. Trotter to make this the subject of his Faraday lecture—an able exposition of both practice and theory to which, by

the courtesy of the author and the Institution, we were able to pay special attention in *The Illuminating Engineer*.

A feature of outstanding importance has been the development of research in illumination, as conducted by the British Engineering Standards Association and the Department for Scientific and Industrial Research. Both these phases of work were discussed in general at meetings of the Illuminating Engineering Society. Since the date of these discussions several of the technical papers prepared by the Illumination Research Committee have been published. In this issue we are including a summary of the latest of these—the very important analysis of the influence of illumination on "fine" work.

Good progress in illuminating engineering has also been made abroad. At the Twentieth Anniversary Convention of the Illuminating Engineering Society in the United States many informative papers were read and summaries of these contributions have been given in recent issues. We have made frequent reference to the papers read before the Illuminating Engineering Society in Germany. We have also recorded with pleasure the formation, in June last, of the Dutch Illuminating Engineering Society; in our last number we published an article by Dr. Halbertsma, its energetic secretary, describing the lighting of the "Gesolei" Exhibition in Düsseldorf, visited by the members of the Dutch Society in October last.

The scientific work of the illuminating engineering societies has been paralleled by vigorous practical propaganda. In this country the educational work of the E.L.M.A. Lighting Service Bureau in London has been supplemented by the rapidly developing efforts of similar centres in the provinces, and during the autumn attention has been concentrated by the E.D.A. and the E.L.M.A. on a campaign for better lighting in the home. Similar work has been proceeding abroad. In Germany this season is being devoted to a campaign on Show-Window Lighting—which, it will be recalled, was dealt with in this country last year.

This brief summary should serve to show that illuminating engineering is essentially a live subject, and there probably never was a time when public interest in lighting was so great as it is to-day. We have no doubt that this activity will be maintained during the present year, and that twelve months hence we shall again have an inspiring record of progress to present.

## The Relation Between Illumination and Efficiency of Fine Work

IN our last number we summarized the contents of the first three technical papers issued by the Illumination Research Committee of the Department of Scientific and Industrial Research. In this number (pp. 14-15) we give an account of the report since issued dealing with the Relation between Illumination and Efficiency of Fine Work, by Messrs. H. C. Weston and A. K. Taylor. This report is issued jointly by the Industrial Fatigue Research Board and the Illumination Research Committee, and has been awaited with great interest. Readers will find full details of this investigation in the summary given on pp. . . . The outstanding point, however, is the conclusion that full efficiency of work (whether judged by output or by accuracy) is only attained when an illumination of the order of 20-25 foot-candles is attained.

This, it may safely be said, is a value rarely attained at present in printing works. The particular process examined, typesetting by hand, was selected as an example of "fine" work. Other forms of fine work will be examined in due course. But there is reason to think that the conclusion applies, broadly speaking, to most forms of difficult and arduous work which make a somewhat severe demand on the eyes.

The importance of the research can scarcely be overestimated. Whilst the relation between illumination and efficiency of work has been generally recognized, very few accurate statistical data of this kind have hitherto been available in this country. Such researches need to be made with great care, and in order to carry weight conclusions must be backed by impartial and representative authority, such as is ensured by the composition of this committee. A specially valuable feature was the co-operation of the Joint Industrial Council of the Printing Trades, with a view to ensuring that the tests (made in an actual printing establishment) correspond with practical conditions. It may also be of interest to note that the experiments give some indication of the lower limit of illumination, below which such work becomes impracticable. Tests were conducted at illuminations down to 1.3 foot-candles. With this low illumination the operators were obviously fatigued—so much so that they were reluctant to proceed with the second day of test!

This research deals only with intensity of illumination. Special care was taken to avoid variation of other conditions. Direct lighting was adopted throughout and the conditions were such as to eliminate, so far as possible, direct glare from the light sources. It need scarcely be said, however, that various other factors—such as effects of glare, the diffusion and colour of the light, the influence of shadows, and the advantages, if any, to be secured by the use of artificial daylight—also deserve attention, and are doubtless being investigated by the committee. As indicated in our last issue, experience abroad suggests that very favourable results may be secured by indirect light, of a colour closely resembling daylight, provided the illumination is sufficiently high and the installation is skilfully arranged. Yet another very important problem is the elimination of glare arising from direct reflection of light from highly polished new type. This is a question that has proved very troublesome in printing works, especially at high illuminations, and it is possible that greater diffusion of light may here prove to be advantageous.

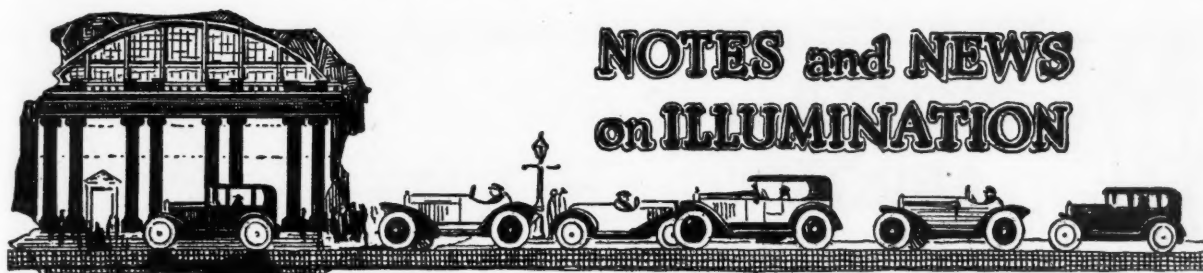
## Illumination and Speed

CONSIDERATION of the results referred to above may well lead one to recognize the direct relation between *light* and *speed* in almost all operations. This is a point that has only been fully appreciated within recent years. It is now many years since the relation between illumination and vision was first tested by oculists. In the conventional test subjects were asked to name correctly the letters, arranged in diminishing size on the standard test-chart. Obviously ability to recognize these letters depends in some measure on the illumination provided, and it was this consideration that led the Council of British Ophthalmologists to devise standard conditions of illumination for test-charts during the war.

But the effect of increased illumination goes far beyond the recognition of a letter. Assuming that the letter is bold and the subject has good vision, it may well be found that maximum acuteness is attained at a comparatively low illumination. But if the speed of reading is tested the effect of increasing illumination is much more marked, especially if the background is dark and the contrast with the letter relatively small. One curious fact, brought out by some tests recently made in the N.E.L.A. Research Laboratory, is that higher illuminations may even compensate for the effect of vibration, such as renders reading more difficult in trains, trams and buses. The presence of such vibration must always be a handicap to vision; but apparently the effect is much more severe when the illumination is relatively low. In vehicles, therefore, we have a special case for the provision of good illumination. This is really another instance of the relation between illumination and visual speed.

The speed factor naturally enters to some extent into almost all industrial operations, the only exceptions being those processes which are purely automatic and could be done with the eyes shut. It also has a very direct bearing on the lighting of streets. The dominant factor here is the continually increasing volume and speed of traffic. In all great cities the congestion of motor traffic has become a serious problem. Everywhere authorities are seeking methods of eliminating delay and enabling streets to carry a larger volume of traffic in a given time. All such steps result in the speed of traffic being continually increased—a fact that has become very noticeable at those centres in London where "one-way" methods have been introduced.

This increase in speed inevitably brings with it the need for higher illuminations. It has been established that the distance at which a driver can distinguish an object on the roadway is largely a function of the illumination provided, either by his headlights or the public lamps. The distance at which it is necessary for him to distinguish objects again depends on the speed of the car. It is easy to pull up a car moving at 10 miles an hour, but the distance within which the car can be stopped becomes rapidly greater, and the interval of time available for him to act less, as speeds of 20, 30, or even 40 miles per hour are reached. The greater the speed of the car the further ahead objects must be visible, and the higher the illumination necessary. Some instructive figures on this point were given in a recent note in the *General Electric Review* (U.S.A.). (See p. 13.) It is a matter which deserves the most careful study by public lighting authorities.



## NOTES and NEWS on ILLUMINATION

### Seventeenth Annual Exhibition of the Physical Society and the Optical Society

This exhibition, which is to be held on Tuesday, Wednesday and Thursday, January 4th, 5th and 6th, 1927, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, will be open in the afternoon from 3 to 6 p.m., and in the evening from 7 to 10 p.m.

On January 4th at 8 p.m. Prof. E. N. da C. Andrade will reproduce with contemporary apparatus a physical lecture of the early-eighteenth century. On January 5th at 8 p.m. Dr. C. V. Drysdale will give a lecture on "Progress in Electrical Instrument Design and Construction," and on January 6th at 8 p.m. Mr. J. L. Baird will give a lecture on "Television." These lectures will be illustrated by lantern slides and experiments. Some 70 firms will exhibit scientific apparatus, and in addition there will be a group of non-commercial exhibits by fellows of the societies and others, including demonstrations of famous historical experiments in physics, recent research and effective lecture experiments.

It has been decided to open the exhibition to the general public without tickets on the third day, January 6th. On January 4th and 5th tickets of admission will be required. Those desiring tickets should apply direct to Professor A. O. Rankine, Imperial College of Science and Technology, South Kensington, S.W.7.

### The Zeiss "Planetarium"

Readers will recall that in Dr. Halbertsma's description of the "Gesolei" Exhibition in Düsseldorf special reference was made to the remarkable Zeiss "planetarium," which enables all the motions of the heavenly bodies to be imitated exactly, and constitutes a wonderful example of the scientific application of light. The obvious educational value of this device has led to its installation in several German cities, where regular demonstrations to schoolchildren and the public are arranged. We are glad to observe that the idea of installing one of these planetariums in London is being seriously considered, and that the project is to be laid before a committee of the London County Council. The Science Museum at South Kensington has been suggested as a suitable site. We sincerely hope that this idea will be carried through and that Londoners will have an opportunity of seeing this remarkable device. We may add that the value of the apparatus depends materially on the choice of a skilled lecturer able to explain the somewhat complex phenomena to the public. Such demonstrations have been made a special feature abroad.

### The Smoke Abatement Bill

Some comments on the Smoke Abatement Bill now before Parliament were made by Dr. C. W. Saleeby in a lecture on "Sunlight and Health," delivered at Newcastle on October 25th. Dr. Saleeby quoted from correspondence with the Minister of Health in regard to domestic coal fires, which are considered to be responsible for more than half the smoke from which the country suffers. He pointed out Local Authorities already had powers under the Housing Act to make provision for such heating and cooking methods as would reduce the amount of smoke emitted from their new houses. It was illogical that, by reason of the phrase "other than private dwelling-houses" in

Clause 5, they should be debarred from the application of such powers to dwelling-houses of all descriptions. It was invidious that persons living in existing houses should be allowed to have an open grate while persons in new houses would be restrained, especially in view of the fact that in some districts smokeless methods are somewhat more costly—a consideration of importance to the poorer classes.

### Optical Society of America

#### ELEVENTH ANNUAL MEETING.

The eleventh annual meeting of the Optical Society in America, held at the end of October, seems to have been marked by an unusually comprehensive array of papers, most of them dealing with optical principles and phenomena, but many of considerable interest to illuminating engineers. There were several papers dealing with colorimetry and a communication of special interest, describing liquid filters for the production of white light, from Messrs. R. Davis and K. S. Gibson, of the Bureau of Standards. Another series of papers dealt with physical optics and spectroscopy, and at the final session there were several papers on photometry. Amongst these may be mentioned: "A Method of Controlling the Intensity of a Small Lamp Without the Use of Electric Measuring Instruments," by A.C. Hardy and F. W. Cunningham; "On the Use of the Integrating Sphere in Reflectometry," by J. K. J. McNicholas; and "An Improved Polarization Photometer," by W. B. Rayton. Professor E. N. Harvey gave a discourse on the "Production of Light by Living Organisms," and Mr. Charles Sheard dealt with "The Effects of Ultra-Violet Radiation upon Growth and Development."

### Bureau of Standards, Washington

#### TWENTY-FIFTH ANNIVERSARY.

On December 4th the Bureau of Standards, Washington, celebrated its twenty-fifth anniversary by a banquet attended by many distinguished guests, at which the achievements of the past quarter century were reviewed. Subsequently an opportunity of inspecting the laboratories of the Bureau was provided. This event should not be passed unnoticed by scientists and engineers in this country. The Bureau occupies a position not unlike that of the National Physical Laboratory, and has been responsible for much varied and useful scientific work, including many researches bearing on illumination. A feature much appreciated in this country has been the free distribution of many of the publications of the Bureau amongst those interested, and the enterprising methods of making the work of the Bureau widely known abroad.

### The Use of Brown Coal for Electric Power Production

An interesting address dealing with the possibilities of brown coal or lignite was recently delivered before the Institution of Fuel Technology by Sir Richard Redmayne. In this country the supplies of such material are of small importance, but the resources of the British Empire are immense. Vast deposits exist in Australia, New Zealand, India and Canada. At present Germany, largely owing to the loss of certain coalfields as a result of the war, leads the world in the utilization of its brown coal deposits. It is estimated that 40 per cent. of the electric power generated in Germany is based on the use of this material.



### Signalling with Artificial Light on Railways

Much interest has been taken in the so-called "day-light signalling" on railways—a term that is essentially confusing, as these signals are in no way dependent on daylight but involve the use of artificial light. The name has arisen through the distinguishing feature of the system, namely, that the signals are bright enough to be used successfully during daylight hours, and it has many manifest advantages. The development of the system is associated mainly with the United States, where it has been actively employed for some years. In 1925 and 1926 some thousands of such signals were already introduced. In France, England and Norway experiments with the system have also been made. In *Licht und Lampe* Herr Buddenberg describes in detail the methods now being adopted in Germany. It is interesting to observe, however, that the fundamental idea is not exactly new. Some 20 years ago the permanent use of oil lamps with suitable lenses and colour-screens was proposed for daylight use. But the arrival of the much brighter and compact electric metal filament lamps has made the scheme a practical proposition. On the German railways the lens system has been worked out with considerable care, the idea being to produce a concentrated beam, readily visible to the engine driver but not easily seen from other directions; hence the use of special protecting screens. According to the author, the system being used on the French railways is based on the use of a parabolic mirror in place of a lens, but in his opinion the use of mirrors is attended with one drawback—that false signals due to images of the sun are less easily avoided.

### Outdoor Decorative Christmas Lighting

In a recent issue we referred to the growing American practice of utilizing light for Christmas celebrations; for example, the custom of exhibiting illuminated Christmas trees in front gardens. According to the *Electrical World* this idea is taking a firm hold of the American public. The mood of the public at this season is attuned to expenditure, and special lighting effects find acceptance as a method of expressing the festive spirit. Communities in various districts have already made organized efforts to develop outdoor Christmas lighting. In many cases the movement has grown from year to year. Thus, in 1922 the Electrical League of Colorado began to spread the idea in Denver, and more than 200 outdoor installations were made by individuals throughout the city. The number doubled in 1923. The next year a contest with prizes was organized, and 800 displays were entered for consideration. In 1925 the number was doubled once more, 1,600 individual lighting displays being arranged. This shows what can be done by enthusiasm, and surely suggests possibilities for enterprising effort by supply undertakings in this country. It may be argued that the display is essentially a temporary one; but any movement to interest the public in the use of light for special displays is worth while, and must ultimately prove favourable to a more liberal conception of the use of light in general.

There is still a tendency for people to be unduly parsimonious in the use of light. If the idea of using light as a natural expression of rejoicing could be fostered it would help to counteract this excessive zeal for economy.

### Luminous Traffic Signals in the United States

An article by Mr. C. E. Egeler in *The Electrical World* shows how rapidly the use of luminous signals for the control of traffic is developing in American cities. Light aids traffic in four chief ways: (1) as guides by marking the pathway; (2) as cautions at dangerous places; (3) for illumination of boulevard or through-street traffic signs; and (4) in furnishing directions when to stop and when to proceed. A special feature is the provision of flashing warning beacons at dead-end streets, bad curves and irregular crossings. The signal is mounted six to seven feet above the roadway, the flashing mechanism being mounted in the base of the pillar. The rectangular base also carries descriptive illuminated signs which serve to amplify the warning given by the flashing beacon above. For "stop and go" signals the use of red light for "stop" and green light for "proceed" has become universal. Developments in this field have led to the design of a special form of lamp which is stated to give 50 per cent. greater signal-brightness, with an increase of only 20 per cent. in wattage.

### A Lighting School in San Francisco

We notice that another "lighting school" has been opened in the United States, this time in the San Francisco district. The main idea is to provide a course furnishing instruction in fundamentals to men in the electrical industry concerned with lighting installations, and the series of lectures appears to have been quite successful, an enrolment of about 50 being secured. The course included demonstrations of glare, contrast, etc., and lectures on domestic and show-window lighting were given. Another useful step recorded is the organization, by the Lighting Committee of the Newark Safety Council, of a course of lectures on industrial lighting for safety engineers, production engineers and similar experts.

### The Ideal Street Lighting Unit

We notice that the discussion abroad regarding the relative merits of concentrating and shallow reflectors for street lighting is still proceeding. The advocates of the relatively deep reflector, completely screening the filament from the eye, base their claims on the predominant importance of avoiding glare. The use of such reflectors gives rise to conditions resembling those in factory lighting. The filament is invisible, and the manifest advantage to drivers of this complete avoidance of glare is presumed to outweigh other drawbacks. Nevertheless the unsightly effect of the upper parts of buildings being in shadow is a manifest disadvantage from the aesthetic standpoint, besides being unfavourable to "visibility." The latest forms of opaque reflector for street lighting seek to alleviate the conditions by the use of a prismatic inner lining which is favourable to an "extensive" curve of light distribution. But even so a shadow line must occur with any opaque reflector. In a recent contribution to *Licht und Lampe* Dr. Ernst Hintzmann recommends a middle course—the use of a special unit with the prismatic glass reflector surrounded by an outer surface of light opal glass. The hard shadow line is thus avoided, as is illustrated by two pictures comparing the effect with that of an opaque reflector. The author agrees, however, in assigning chief importance to the avoidance of glare.



Floodlighting

By

W. J. JONES, H. LINGARD and T. CATTEN

(Paper to be presented at the Meeting of the Illuminating Engineering Society, to be held at the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, Strand, London, W.C.2, at 6-30 p.m., on Tuesday, January 11th, 1927.)

Introduction

It is difficult to assign a definite date to the introduction of floodlighting, since for many years there has been a desire to spread light evenly over a surface in contradistinction to the patchy effects obtained with a multiplicity of lighting units. Without doubt, its practical development has been brought about by the design of searchlights which could illuminate objects from a considerable distance. Fresh uses for floodlighting are continually being discovered, for as a method of illumination floodlighting has almost unlimited possibilities, and in many instances provides the only practical method of solving some lighting problems. The old method of outlining important buildings with lamps or installing large lighting units in the vicinity gave an unsightly appearance, as well as proving glaring to the onlooker. The floodlight units, however, can be concealed, and lighting by these means will bring the front of the building into relief, and even accentuate the structural lines. Architects now welcome the introduction of floodlighting, as it makes their buildings visible for a larger number of hours, and often the floodlighted building will be more outstanding at night-time than during the day. Occasionally the objection is made that floodlighting produces unnatural shadows. During daytime the shadows from the features of a building necessarily fall from above, and it should be realized that this effect cannot be entirely simulated by present floodlighting methods, but the advantages of floodlighting in other directions invariably overcome this objection. By directing projectors from several positions and allowing the light to reach the surface from a variety of angles, many of the objectionable and unnatural shadows can be avoided. If contact can be established with the architect while the building is in the embryo stage the floodlighting arrangements may be made an integral part of the edifice and suitable positions for units readily provided. Another important field for floodlighting is the lighting of posters for advertisement purposes. Although a number of individual units provide satisfactory illumination of relatively small posters, the problem of lighting large hoardings can only be satisfactorily accomplished by the installation of floodlight equipment. On a large hoarding the individual reflector invariably gives patchy results, while illumination provided by floodlights can be extraordinarily even, besides being superior on the score of efficiency. Furthermore, the fact that the lighting units themselves can be readily screened from view improves both the night and day appearance of the installation. There are many other special uses for floodlighting, such as the lighting of exhibitions and industrial work, but it is proposed to confine attention to the more general problems.

FACTORS INVOLVED IN FLOODLIGHTING PROBLEMS.

The successful solution of a floodlight problem depends upon a number of different factors, which can be approximately grouped as follows:—

- 1. The brightness of the installation.
- 2. The choice of type of equipment.
- 3. The total energy required for installation.

This last is largely dependent on factors 1 and 2.

1. *Brightness of Installation.*—The problem in all classes of floodlighting is to make the object lighted stand out from its surroundings. Brightness is the only quantity that the eye can appreciate, and hence it follows the greater the brightness of a floodlighted building the more outstanding will be the installation.

(a) *Reflectivity of Building.* For a given amount of illumination the brightness will depend upon the reflecting properties of the subject. A grey surface of 20 per cent. reflectivity requires four times the light to appear equally bright as a white surface of 80 per cent. reflectivity.

If  $\alpha$  be the reflectivity of a substance and  $E$  the intensity of illumination, then the brightness  $B = \frac{\alpha E}{\pi}$  candles per square foot.

An indication of the reflectivities of building surfaces is given in Table I. They were obtained from a number of tests made with a portable photometer on buildings in the London area:—

TABLE I.

Material	Condition	Reflectivity
		per cent.
White glazed brick .. ..	Clean	85
Yellow brick .. ..	New	35
Red brick .. ..	New	25
Brick .. ..	Dirty	1-5
White marble .. ..	Fairly clean	60-65
Granite .. ..	Fairly clean	10-15
Light concrete or stone ..	Fairly clean	40-50
Dark concrete or stone ..	Fairly clean	25
Concrete or stone .. ..	Very dirty	5
Concrete painted buff ..	New	50

(b) *Brightness Factor.* A building illuminated to a given brightness will stand out more or less from its surroundings according to the brightness of objects or buildings in the immediate vicinity. Such contributory matters as the street lighting and the degree of isolation of the object to be floodlighted are equally important. Each prevents the building from "standing out." It is quite obvious that a building in an important and

well-lighted street will require greater illumination than one in the suburbs, while the lighting of a monument, entirely isolated, will require much less expenditure of energy.

Yet a further factor is the size of the lighted object. Where a floodlighted object subtends a large angle of view, in general, a lower brightness is requisite.

In practice, the fact that a panel at the top of a building is isolated from bright surroundings and competitive light is therefore absent, there is little need to provide extra light due to the elevation of the object and the consequent smaller angle that it subtends to the eye. This would not, however, be true if it is essential that the panel should be viewed from a great distance. It equally follows that small areas floodlighted near the ground require some 50 to 100 per cent. more light than is required for areas which subtend a larger angle of view, other things being equal.

The following table gives some values of foot-candle intensities required on different building surfaces, taking into consideration the brightness of the surroundings and the reflectivity of the surfaces. This table is based on the reflecting powers of different surfaces and the careful analysis of successful floodlighting schemes in the London district. We do not see why these figures should not apply to provincial areas, since the central area of a provincial town is often as bright as that in London.

TABLE II.

Foot-candle intensity required on different building surfaces, taking into consideration the brightness of surroundings.

Material	Condition	Reflectivity	FOOT-CANDLES		
			Poorly Lighted District	Medium Lighted District	Brightly Lighted District
White glazed brick	Clean	85	2	3	5
Yellow brick	New	35	4	6	10
Red brick	New	25	6	9	15
Brick	Dirty	1-5	Usually requires too much light to be practicable.		
White marble	Fairly clean	60-65	2½	4	7
Granite	Fairly clean	10-15	13	21	33
Light concrete or stone	Fairly clean	40-50	3	5	8
Dark concrete or stone	Fairly clean	25	6	9	15
Concrete or stone	Very dirty	5	Usually requires too much light to be practicable.		
Concrete painted buff	New	50	3	5	8

The figures given above will be found satisfactory for the majority of problems, but should be modified when abnormal conditions prevail (size, etc.).

Although it is generally desirable that light should be evenly distributed over the surface, there are a number of instances where gradation of intensity is advantageous, permitting some features to be accentuated with good effect. Since, however, this is a special aspect of a particular problem, it should not materially affect general procedure.

**Poster Lighting.**—The desirable intensity of light for the illumination of posters has been carefully investigated, and it is possible to assign some figures of relative importance to such matters as competing illumination, nature of poster surface, and the general character of the poster colour, design, etc.

The following table gives a guide to the degree of illumination that is required for satisfactory poster illumination:—

TABLE III.

Foot-candle intensity required on posters.

Type of Poster	District Poorly Lighted	District Medium Lighted	District Brightly Lighted
Ordinary posters on hoardings matt surface	5	10	15-25
Glossy surface	Increase 10%	Increase 10%	Increase 10%
Posters with intricate pattern	Increase 10%	Increase 10%	Increase 10%

**Precise Purpose for which Floodlighting is Designed.**—The figures given in Tables II and III are those which may ordinarily be employed to obtain an effective result with due economy for the usual lighting of buildings and posters. It will, however, be realized that such values would be quite inadequate for the floodlighting of buildings in exhibitions or for providing special "stunt" effects. The blaze of light required under these conditions is rather a different problem, requiring considerably higher illumination and not so vigorously limited on the ground of expenditure, since these installations are usually of a temporary nature.

**Cleaning of Building Fronts.**—On a number of occasions the fronts of buildings have been successfully cleaned and treated to facilitate floodlighting, since the amount of energy required to give satisfactory results is so much dependent upon the reflectivity of the surface. In the majority of cases cleaning can be effected at a cost of between 4s. 6d. and 7s. per square yard of building front. The higher figure would be operative where the architecture is particularly florid in nature.

**2. The Choice of Type of Equipment.**—It has already been pointed out that the floodlight is closely allied to the searchlight in design. The modern searchlight represents a triumph of optical and engineering ingenuity, and depends essentially upon an accurate design of the optical system and the ability to obtain a steady and concentrated light. Fortunately, the floodlight is not so much limited by either of these factors, for, in the first place, smaller and less accurate mirrors suffice, and the modern gasfilled lamp gives a sufficiently steady light.

**Beam from Parabolic Reflector.**—The beam from a parabolic reflector when a point source (an entirely imaginary thing) is placed at its focus is produced by reflected rays which are all parallel, so that the divergence of the beam would be nil. When, however, we consider a source of finite size, the reflected rays from the mirror diverge, as is clearly shown in Fig. 1.

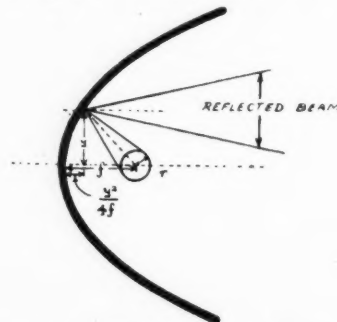


FIG. 1.—Reflection from parabolic mirror.

If we consider a uniform spherical light source we can imagine that instead of receiving a single ray of light from the light source the mirror receives and reflects a cone of light, the angle of the cone before and after reflection being the same.

Let  $r$  = radius of a spherical source and  $f$  focal length of the reflector. Then semi-angle of divergence of beam reflected from point  $y$  on the mirror is:—

$$\sin^{-1} \frac{r}{oy} = \sin^{-1} \frac{r}{\sqrt{\left(f - \frac{y^2}{4f}\right)^2 + y^2}}$$

when  $y = 0$  this becomes  $\sin^{-1} \frac{r}{f}$

On this basis it is possible to estimate the approximate beam divergence of a floodlight, but such a procedure is fraught with a certain number of difficulties. In the first place, the mirrors used are not always parabolic in contour; and, secondly, the light sources are by no means uniform. Again, this estimated beam divergence is only true providing the light source is placed in the focal position. That any deviation from this position inevitably results in greater divergence is clearly shown in Figs. 2 and 3. In Fig. 2 the light source is shown placed behind the focus, and in Fig. 3 it is shown beyond the focus.

This fact is made full use of in the design of flood-lighting lanterns in order to distend the beam so that it covers the subject.

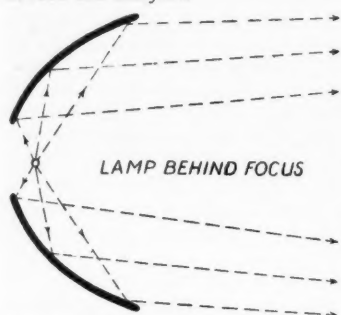


FIG. 2.—Reflection from parabolic mirror.

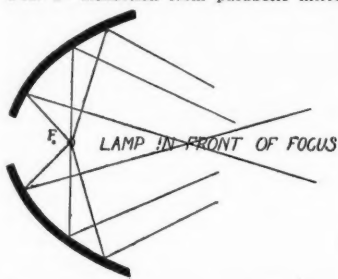


FIG. 3.—Reflection from parabolic mirror.

intrinsic brilliancy, brought about by the greater efficiency of the larger lamp.

It has been shown by several writers\* that the inverse square law can be applied to the parabolic reflector as a source of light, provided the original source of light is small compared with the diameter of the mirror. Walsh gives the following limitation:—

$$\frac{\text{Minimum distance for measurement}}{\text{Focal length of projector}} = \frac{\text{Diameter of projector}}{\text{Diameter of source}}$$

The theoretical treatment of this problem generally assumes that a solid source of light is available, and that the whole mirror can be made to flash. Now the floodlight unit is not such a well-defined optical instrument, and in general such rules will not apply. Fig. 4 shows a set of curves applicable to one particular mirror. Each

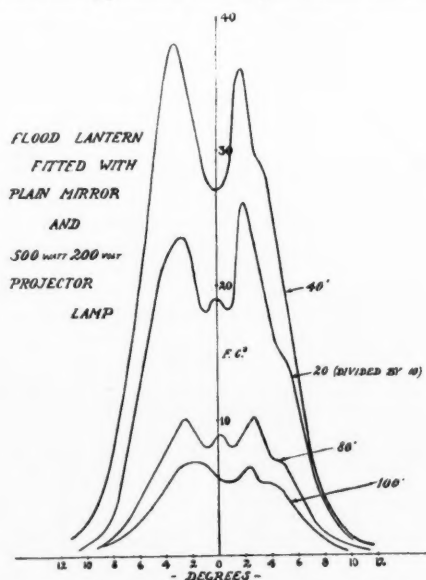


FIG. 4.—Illumination curves at different distances from floodlight.

has the same characteristic shape, the peaks corresponding to filament images. In such units the focal length is small compared with the diameter of the mirror, and in few instances will the mirror flash as a whole; while lack

of uniformity of the light source increases the difficulty of a predetermination of the distance at which readings can be taken to give reasonable results to conform with the inverse square law. Photograph in Fig. 5 shows a

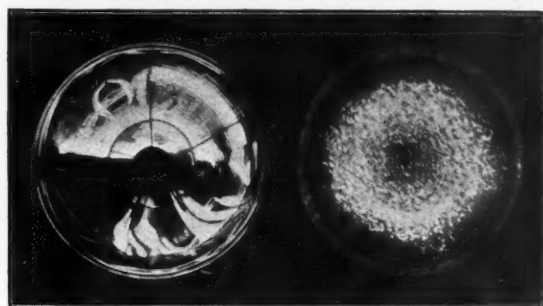


FIG. 5.

FIG. 6.

flashing mirror with a projector lamp; note the effect of filament gap and the effects of back reflection and refraction of the lamp bulb.

The sections of mirror that flash to any one position vary according to the distance away along the axes and the inclination to the axis. In Fig. 6 a translucent screen is placed immediately in front of the projector, and shows readily which part of the reflector contributes most of the light.

**Sectional Mirrors.**—In recent years there has been a considerable increase in the manufacture of floodlight units with built-up mirrors; in each case the sections are assembled to approximate parabolic conditions. The theory of these units is fully dealt with by Benford.† These floodlights possess similar properties to the

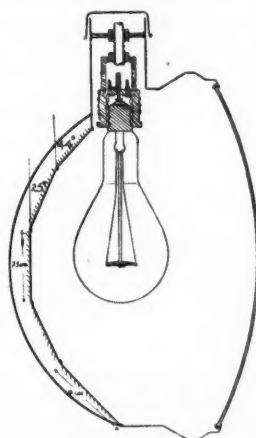


FIG. 7.—Sectional mirror floodlight.

parabolic-mirror floodlight when fitted with diffusing mirror or diffusing-glass front, for the beam has a softness of outline and uniformity of intensity so valuable in the satisfactory floodlighting of architectural features. The beam spread, however, is considerably greater than that obtained with plain parabolic mirrors, and it should also be borne in mind that this spread is obtained at the expense of beam intensity, so that their use is almost entirely confined to short-range projection.

Unlike the parabolic reflector, the beam intensity of these sectional mirror floods is largely independent of the intrinsic brilliancy of the light source, since the beam produced is obtained from a number of images, and

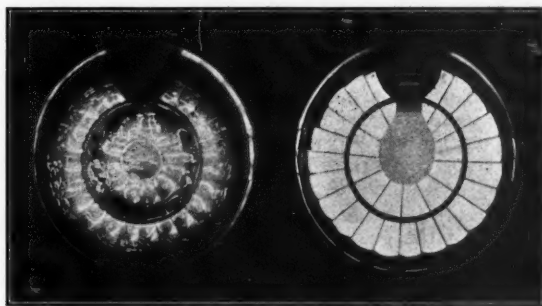


FIG. 8.

FIG. 9.

depends therefore on candle-power rather than brilliancy. It is, moreover, largely independent of the size or form of source. Each flat section of the mirror reflects an independent beam of light, the cross-section of which resembles the outline of the section of the mirror, and the

\* Particularly J. W. T. Walsh, Proc. Optical Convention, 1926.

† General Electric Review, December, 1925, p. 866.

intensity is proportional to the candle power from the source in the direction of the plane mirror in question. Most of these mirrors are built up with the sections arranged in zones about the axis. Fig. 8 shows a photograph of such a flood, and indicates clearly the images that are produced. Fig. 9 shows the images produced when a white lamp is employed.

Yet a further advantage of this form of floodlight is the fact that it can be designed specifically for use with standard gasfilled lamps, and at the same time gives a uniform beam.

**Definition of Beam Spread.**—Although from theoretical considerations it is possible to predict the approximate beam spread of a floodlight projector, some

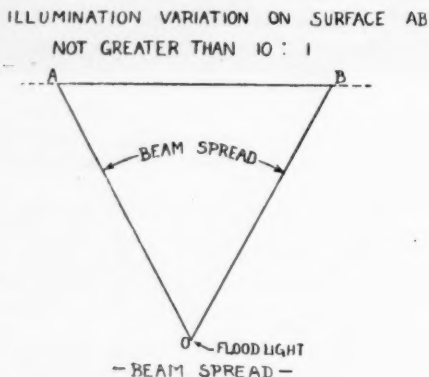


FIG. 10.

difficulty has arisen in the precise definition of the term itself. In any problem involving the projection of light one of the matters that most interests the engineer is the diversity of light on the subject, and it will be obvious that this is intimately connected with this question of divergence. A good deal of confusion exists; some authorities have defined the beam spread as being the angle at which the candles of the beam drop to 10 per cent. of their maximum value; yet others, as a result of experience in floodlighting, have taken a 25 per cent. figure as being more useful.

Now the object in each instance is to define under what conditions the variation in intensity of illumination on the lighted surface becomes objectionable. It is for this reason that the following definition is proposed:—

“The beam spread of a floodlight is the angle within which the illumination on a surface, normal to the axis of the floodlight, does not vary more than 10 to 1.”

This definition takes into consideration the increased distance that the edge of a beam has to go before reaching the subject, and also the “cosine law.”

$$\text{C.P. edge of beam} = \frac{\text{C.P. centre of beam}}{10} \times \cos^3 \theta/2$$

where  $\theta$  is the beam spread as defined above.

For beams of small divergence there is little practical difference between all these ways of working, but when beams of considerable divergence, which are more commonly used in this country, are being considered, then it becomes of great importance. For instance, consider a projector with a beam spread of  $45^\circ$ , according to the 10 per cent. candle-power basis. On this basis, due to increased distance traversed by edge of beam and operation of “cosine law,” there is a variation of intensity on the surface from such a projector within the angle of  $45^\circ$  of no less than 40–50 to 1.

**Methods of Providing Even Illumination.**—Since the filament of the gasfilled lamp is far from uniform, the resultant beam from a plane parabolic mirror is invariably uneven and produces streaks on the lighted surface. In a number of instances where the lighted surface is broken up with decoration or window space the appearance of the streaks is hardly noticeable, but when a flat surface is so illuminated the streaks are particularly objectionable. There are several methods by which this streakiness can be avoided:—

1. Diffusing mirrors. These mirrors, while retaining their general parabolic contour are indented or

corrugated, and in this manner the hard lines of the filament image are broken up.

2. Diffusing-glass front. A diffusing glass placed over the front of a floodlight breaks up the original beam of light. The glass usually employed has an uneven muffled surface, although rough sand-blasted glass may be useful at times, being, however, difficult to keep clean. The uneven surface of the diffusing-glass front should always be placed inward towards the lamp to lessen the accumulation of dust and dirt.

3. Sectional mirrors. These are described above.

4. White lamps. The white lamp can be effectively used to eliminate undesired streakiness, and give soft outline to the beam.

When any attempt is made to diffuse the beam by one of these methods there is simultaneously an increase in beam width and a reduction in beam candle-power. The following table shows the results of some tests made on one type of floodlight:—

TABLE IIIA.

Type of Unit	Size of Lamp	Beam Spread
Plain parabolic mirror ..	250-watt floodlight lamp	$32^\circ$
Diffusing parabolic mirror..	Do. do.	$44^\circ$
Plain parabolic with diffusing glass front ..	Do. do.	$46^\circ$

These results are perhaps more strikingly shown in Fig. 11, where all three curves are shown.

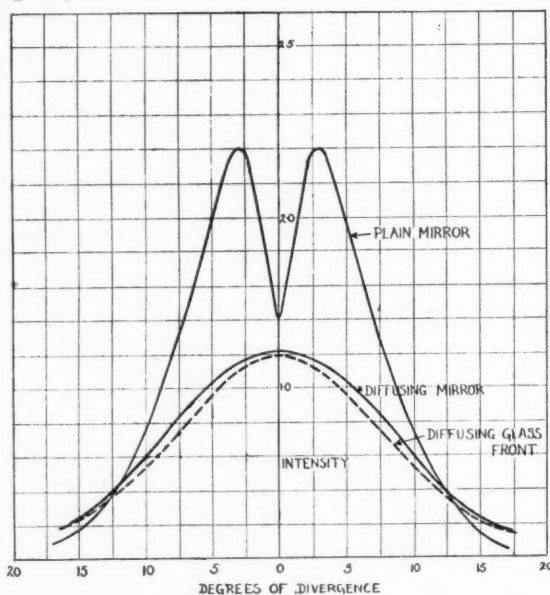


FIG. 11.

Table IV gives results for a sectional mirror flood, and compares the effects of clear lamps and white opal or white-sprayed lamps.

TABLE IV.

Beam Spreads for sectional mirror type floodlight using clear and white lamps.

300-watt High-voltage Standard G.F. Lamp		300-watt High-voltage White Lamp	
Beam Spread	Max. Beam Candle-power	Beam Spread	Max. Beam Candle-power
$52.5^\circ$	12,000	$110^\circ$	2,500

**Types of Floodlights.**—Floodlights can be approximately divided into two types, namely, those giving an intense and concentrated beam and those giving a wider and less powerful beam. Units of the searchlight type employing projector lamps give a beam spread of a few degrees, and are usually employed at a considerable distance from the object to be lighted, while others using standard lamps give a wide distribution of as much as  $90^\circ$  degrees.

The following table indicates the distance at which it is common to employ units of different beam spread:—

Beam Spread	Usual Distance from Surface
Up to 10°	100-400 ft.
About 15°	80-250 ft.
About 30°	40-130 ft.
50°-90°	10-75 ft.

**Asymmetric Distribution.**—Most floodlights give approximately symmetrical distribution of light, the deviations from a circular beam being less than would have been anticipated in view of the nature of the light source. There are, however, occasions when definite asymmetry is desirable, and one method of producing

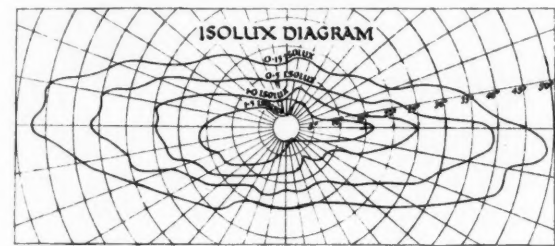


FIG. 12.—Floodlight fitted with spreading glass.

this involves the use of a “spreading glass,” which is essentially a sheet of clear glass ribbed on one side, the light being spread outward at right angles to the ribs. Fig. 12 illustrates the isolux diagram for a floodlight fitted with such a spreading glass.

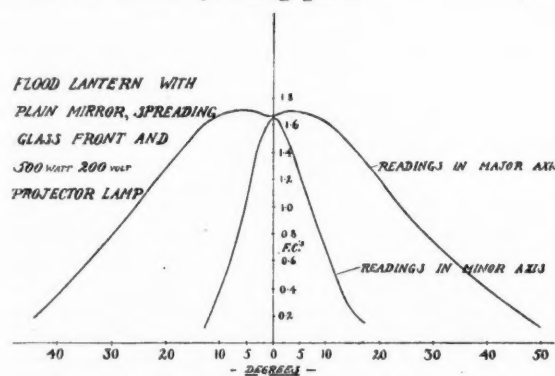


FIG. 13.

In carrying out this test the floodlight was set up on a turntable, so that it could be rotated horizontally. The ribbed spreading glass was set with its axis vertical, and readings were taken of the foot-candle intensity at a distance of 50 feet at different angles in the horizontal plane. The spreading glass was then rotated by 10-degree steps and similar sets of readings taken. By this means it was possible to obtain a number of intensity values virtually on the surface of a sphere 50 feet radius. Fig. 13 indicates the distribution in the horizontal and vertical axes, and, judging beam width on the basis of the definition given under “Beam spread,” the beam spread is 95° horizontally and 27½° vertically. Such spreading glasses have often been used for lighting objects which are much longer than they are wide, e.g., boardings or a chimney shaft.

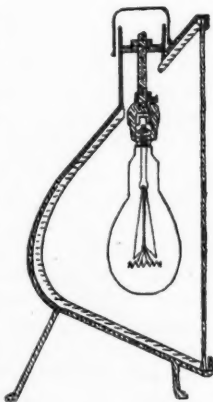


FIG. 14.—Asymmetric floodlight.

An altogether different type of floodlight giving a definitely asymmetric beam, and designed for standard lamps, is illustrated in Fig. 14, which shows the contours of the mirrors on a section taken vertically through the centre. The glass mirrors themselves are ribbed and give a vertical spread. Fig. 15 shows the

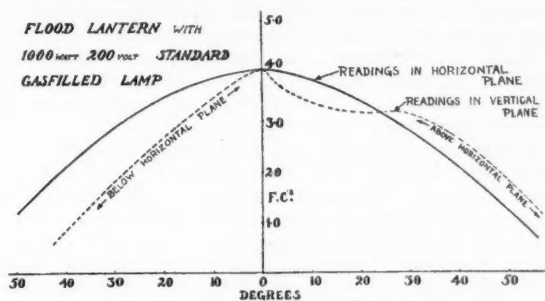


FIG. 15.—Light distribution from asymmetric floodlight.

distribution of light in a vertical and horizontal plane, while Fig. 16 shows the isolux diagram obtained from such a unit. This unit was mounted on a turntable, and readings taken in a somewhat similar manner to that already described, but means were provided to tilt the unit backwards and forwards in order to obtain readings at various angles outside the horizontal plane.

**Coefficient of Utilization.**—The lumen method of calculating illumination schemes is well known in its industrial and commercial application, and has been used in the design of floodlighting schemes. Unfortunately, little information has been available regarding the efficiency of floodlight units. Some manufacturers have published beam lumens which only apply to their own particular units, but, as far as we are aware, information regarding the performance of different types of units, particularly those which are more common in this country, namely, those units giving wide beam divergence, has been entirely lacking.

Certainly information has not been available on the efficiency of asymmetric floodlighting units and units with sectional mirrors. An endeavour has therefore been made to test representative types of floodlights. Symmetrical units were tested for beam spread, and from the distribution curves so obtained an estimate of the lumens within the beam as defined on page 8 was obtained by summation methods.

Of the total lumens generated by an electric lamp only a portion are directed to the surface that it is required to illuminate. Some small proportion of the light is absorbed by the mirror and glass front, while a much larger proportion (bare lamp light) is not controlled at all, and may therefore be considered as waste light.

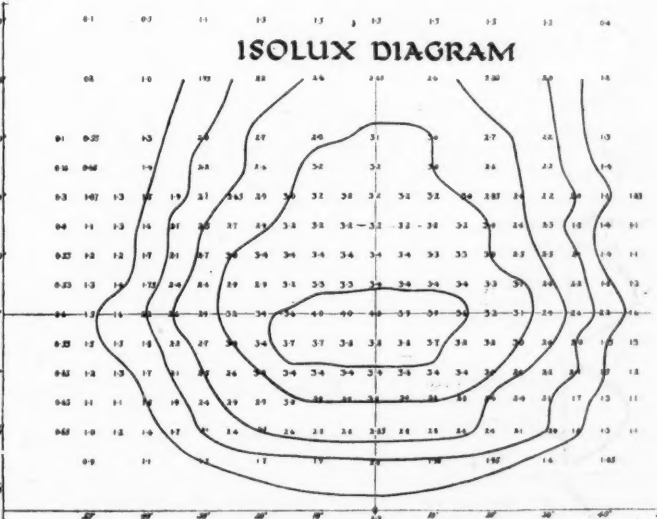


FIG. 16.—Isolux diagram of asymmetric floodlight.

Since the amount of light reflected by a parabolic mirror depends upon the solid angle that the mirror subtends to the light source when the source is placed at the focus,

it is possible on this basis to divide units roughly into two categories:—

- (a) Those with shallow parabolic mirrors.
- (b) Those with deep parabolic mirrors.

The utilization factors obtained indicated that this was a reasonable procedure, while coefficients were also obtained for sectional mirrors, diffusing mirrors and floodlights fitted with diffusing-glass fronts.

Table VI represents the summary of these results. In every instance an average was taken of the results obtained when the lamp was in its back, mean and forward positions.

The beam spread that will be obtained from any floodlight will depend upon the construction of the lamp itself (filament dimensions) and the adjustment of the lamp position, but the variation in coefficients of utilization due to different dimensions of various makes of lamps is small. The variations of beam spread become less important, due to overlapping, etc., when a number of units are employed to light a large area.

**Results from Floodlights giving Asymmetric Distribution.**—Two methods of obtaining asymmetric light distribution from a floodlight were examined and isolux diagrams drawn as indicated in Figs. 12 and 16. By means of a planimeter the areas between successive isolux lines were estimated and the appropriate calculations made in each case to reduce results to equivalent areas on a sphere for lumen calculations.

**AREA COVERED BY BEAM.**—The type or types of projectors required for a given installation will depend upon the area to be lighted and the position at which the floodlights may be placed. Where there is a latitude of position several alternative floodlights are available. If, however, the distance is fixed, then a floodlight must be selected which has sufficient beam spread to light the whole surface or a definite proportion of it. A drawing to scale of the building, with the position of the unit marked, will readily give the minimum beam spread

necessary; alternatively this information can be obtained direct from the following formulæ:—

- (a) Normal projection.
- (b) Oblique projection.

(a) A symmetrical design of floodlight when directed at right angles to a surface projects a circular patch of light. For a beam of known divergence or beam spread the area covered will vary with the distance from the unit to the object, and the intensity will be reduced in proportion.

Let  $d$  be the distance between the floodlight and the surface to be illuminated, and the beam spread be  $\theta$  degrees, then

$$\text{Area covered} = \pi \tan^2 \frac{\theta}{2} \times d^2$$

(b) When the beam is directed obliquely the area lighted will be elliptical. Let the floodlight be tilted

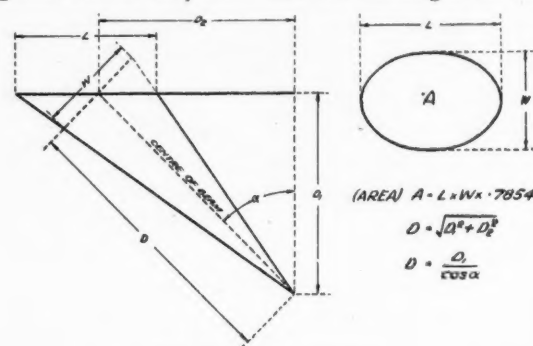


FIG. 17.—Oblique projection.

obliquely at an angle of  $\alpha$  degrees from the normal to the surface to be lighted, then the area of the ellipse so lighted is given by the following formulæ:—

$$\text{Area covered} = \frac{\pi}{4} \times \text{width of ellipse} \times \text{depth of ellipse.}$$






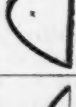

The depth of the ellipse is  $2d \tan \frac{\theta}{2}$

The width of the ellipse is 
$$\frac{2d \tan \frac{\theta}{2}}{\cos \alpha}$$

**Constructional Design.**—The heavy optically ground mirror of the searchlight must be provided with expensive and rigid housing. The light and less expensive mirrors of the floodlight can be safely mounted in sheet-metal cases for most commercial purposes. Purely industrial applications, however, often necessitate the maximum sturdiness in design of the whole equipment, and in such instances the mirrors are housed in heavy castings. Another factor that must be borne in mind is the necessity of the housing to withstand climatic conditions (smoky atmosphere or conditions on sea front); for instance, in the Midlands, sheet-copper housings or at least a metal coated with anti-sulphuric enamel must be used.

The majority of floodlights employed for the lighting of buildings are of quite light construction, and thus manufacturing costs are reduced to a minimum. Floodlights should be provided with adequate ventilation to deal effectively with the heat generated by the gasfilled lamp. Experience has shown that the maximum amount of adjustability is desirable, and effective tilting and swivelling arrangements should therefore be incorporated in the design of equipment. Fig. 18 shows a cast-iron fitting of rugged construction for bolting down, while Fig. 19 shows another type which is provided with a clamp for bolting to a post or rail.

TABLE VI.  
Characteristics of Commercial Floodlights.

Type of Mirror	Lamp Size and Type	Beam Spread High Voltage	Coefficient of Utilization
 Deep parabolic plain mirror	500-watt projector 250-watt projector	18°–28° 28°	55% 45%
 Shallow parabolic plain mirror	1,000-watt standard gasfilled 500-watt standard gasfilled 500-watt projector	32° × 24° adjustable to wide limits 20° × 22° adjustable 9°–14°	40% approx. 40% approx. 44%
 Deep diffusing mirror	500-watt projector 250-watt projector	65° 35°	50% 32%
 Sectional glass mirror	300-watt–1,000-watt standard gasfilled 500-watt projector 300-watt white	45°–65° 48° 74°–80°	45% 44% 45%
 Diffusing glass front and plain mirror	250-watt projector	44°	35%
 Spreading glass front and plain mirror	500-watt projector 250-watt projector	60° × 20° to 90° × 30° —	40% approx. —
 Ribbed mirror square pattern flood lantern	500-watt–1,000-watt standard gasfilled	Whole beam 96° × 90° When on the ground 96° × 60°	55%

NOTE.—Low voltage lamps give somewhat less beamspread.

**Cover Glasses.**—The chief purpose of a cover glass is to make the unit weatherproof, but in some instances this glass door has been designed to have useful optical properties. Such cover glasses are, however, rarely used in commercial floodlighting equipment. The whole question has been studied by Benford,\* who has investi-



FIG. 18.

FIG. 19.

FIG. 19A.

gated the effect of the front glass on beam spread and efficiency. The chief point that emerges as far as floodlights in this country are concerned is the unequal heating of the front glass due to reflection and refraction from the bulb of the lamp. It is shown that the lamp bulb reduces heating of the glass immediately in front of it, but causes extra heating beyond this. It is also noticeable by considering Fig. 6. (Here the light is chiefly concentrated towards the edges of the door.) The unequal heating produced causes stresses to be set up within the glass, and the slightest wetting of the exterior often causes cracking. For this reason special ventilation arrangements must be provided or else strip glass fronts employed, when large-wattage lamps are installed. Domed-glass fronts are frequently employed, as they possess great mechanical strength, while the glass is well removed from the lamp itself. With adequate ventilation they are satisfactory for most floodlight units.

**Anti-glare Shields.**—In addition to the beam proper from a floodlight which consists essentially of light that is controlled by the mirror, the light emitted from the front of the lamp spreads forward in all directions, and at times may detract from the usefulness of a floodlight. For instance, consider a beam directed nearly parallel to a wall. The bare lamp light illuminates the wall, and "competes" as regards visibility with the object on which the main beam is directed, and furthermore it undesirably reveals the actual location of the floodlight itself. Or, again, consider the floodlighting of an object by means of projectors, throwing across a street. In this type of installation the bare lamp light will often not only be an annoyance, but will, due to glare it creates, prove a positive danger to traffic. In some

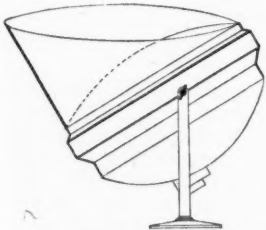


FIG. 20.—Simple anti-glare shield.

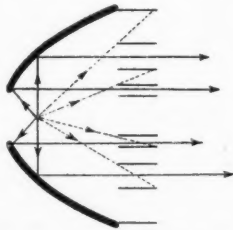


FIG. 21.—Action of anti-glare shield.

instances a simple shield fitted to the sides of the floodlight, as illustrated in Fig. 20, will materially assist in obviating this difficulty, and prevent the bare lamp light reaching the eye of the observer in the street.

A more complete device consists of a number of concentric cylinders, the surfaces of which are blackened. The useful beam emerging from a floodlight in approximately parallel lines can pass freely through, while the bare lamp light coming at all kinds of angles is effectively blocked. In practice the non-reflector concentric rings are slightly coned to meet the beam divergence of the particular floodlight in use. (See Fig. 21.) In some instances vertical slats or louvres, similar in principle to a venetian blind, can be used with equal effect. It cannot be overemphasized that some form of shield should always be used whenever there is the slightest chance of glare causing inconvenience to the passer-by, particularly as its employment does not involve any loss in the effectiveness of the beam.

3. THE ESTIMATION OF NUMBER OF UNITS AND SIZE OF LAMPS. **Lumens Required at Surface.**—From Table I select the desired foot-candle intensity and calculate from the dimensions of the building or poster the total surface to be lighted in square feet.

Lumens required at surface = area to be lighted  
× foot-candles.

**Spill or Waste Light Factor.**—The coefficient of utilization does not take into consideration any light that may be spilt over the edge of a building. It very seldom happens that the objects to be lighted are the exact shape of the beam cross-section. Consider, for instance, a circular beam of 25 ft. diameter lighting a square object 17 ft. 6 in. each side. Then the shaded portion on the diagram represents the part of the beam that is wasted. For a square surface, as shown, the loss may be 30 per cent., while for a rectangular surface it may be even greater.

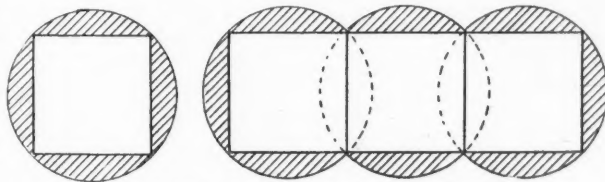


FIG. 22.—Illustrating spill or waste light.

Where, however, a large building is concerned involving a number of units the loss will not be quite so great. This is clearly indicated in the accompanying illustration. When the surface to be lighted is very irregular in contour it is better to mark on the elevation of the building the area covered by each flood, and to estimate in this way an allowance for spilt light. For ordinary square or rectangular buildings a spill factor of 1.25 to 1.5 is usual, although for a very irregular building an allowance as high as 2.0 or more may be required.

**Depreciation Factor.**—All outdoor lighting apparatus requires periodical cleaning, and in order to make some allowance for the drop in illumination which occurs between the cleaning periods and to take into account the falling-off in light output of the lamp, a depreciation factor is required. A figure of 1.5 is usually sufficient, but where the deposit of dirt is likely to be unusually heavy or where floodlights are installed in inaccessible positions, a factor of 2 should be used.

**Coefficient of Utilization.**—Table VI gives the proportion of lamp lumens that is projected within the limits of the beam, as defined under "Beam spread."

**Total Lumens Required.**—The total lumens can now be obtained as follows:—

Lumens required =

Square feet to be lighted × Depreciation factor × Spilt light factor × Foot-candles  
Coefficient of utilization

**Size of Lamps and Number of Floodlights Required.**—Some types of floodlights are designed in several sizes to accommodate various wattages of gasfilled lamps. It is cheaper from the point of view of efficiency to use a few large units in preference to a number of smaller ones, although a number of units give results of higher artistic merit since there is a greater overlapping of beams, and in some cases apparent distortion of the building front is avoided.

\* General Electric Review, Vol. xxix, No. 7, July, 1926, p. 551.

For a given size of lamp the number of units required can readily be obtained by comparing the total lamp lumens to be generated with the lumen output of one lamp.

**Colour.**—The above procedure should facilitate the solution of the majority of floodlighting problems when white lighting alone is considered. Similar methods can be employed when colour is introduced, providing sufficient lamp wattage is allowed, to compensate for the absorption of light by the colour screens. Coloured floodlighting has met with most success in exhibitions where the building face is generally new and clean. Perhaps the most satisfactory method of employing colour in floodlighting is to use contrasting colours in such a manner that the background of the building is illuminated in one colour, while the prominent features are picked out in some complementary tint.

#### CONCLUDING REMARKS.

One of the reasons why floodlighting has not been used as extensively as it deserves is due to the fact that the average engineer has been unable to estimate the wattage required to give a satisfactory installation.

It is hoped that the suggestions contained in this paper will be found to form a useful basis for calculating floodlighting schemes, and assist the engineer in the general problems involved.

#### LUMENS RATINGS AND DIMENSIONS OF GAS FILLED LAMPS, AS PER B.E.S.A. SPECIFICATION No. 161, 1924.

Rating		Approx. Rated Lumens	Maximum Overall Dimensions			Light Centre Length with Standard Cap Tolerance $\pm$ 10 per cent. with max. of 10 mm.	Standard Cap
High Voltage 200-250	Low Voltage 100-137		Length	Diam. of Bulb	Diam. of Neck		
100	..	1,100	mm. in.	mm. in.	mm. in.	mm. in.	B.C.
..	100	1,250	170 6.7	82 3.2	42 1.7	120 4.8	B.C. or
150	..	1,720	170 6.7	92 3.6	45 1.8	120 4.8	E.S.
..	150	1,970	180 7.1	92 3.6	45 1.8	130 5.2	E.S.
200	..	2,310	215 8.5	103 4.1	48 1.9	150 5.9	E.S.
..	200	2,730	250 9.9	113 4.5	55 2.2	180 7.1	G.E.S.
300	..	3,930					
..	300	4,260	280 11.1	133 5.3	60 2.4	205 8.1	..
500	..	7,110	340 13.4	173 6.8	70 2.8	250 9.9	..
..	500	8,000	340 13.4	173 6.8	70 2.8	250 9.9	..
1,000	..	16,000	340 13.4	173 6.8	70 2.8	250 9.9	..
..	1,000	17,100	340 13.4	173 6.8	70 2.8	250 9.9	..
1,500	..	24,830	340 13.4	173 6.8	70 2.8	250 9.9	..
..	1,500	25,700	340 13.4	173 6.8	70 2.8	250 9.9	..

#### Approximate Lumens Ratings and Dimensions of Projector Lamps for use in Floodlights.

High Voltage 200-250	Low Voltage 100-130	Approx. Rated Lumens
100	..	1,100
..	100	1,250
250	..	3,200
..	250	3,500
500	..	7,110
..	500	8,000
1,000	..	16,000
..	1,000	17,100



FIG. 23.—Lighted from units placed in courtyard.

#### NOTES ON INSTALLATION.

The success or otherwise of a floodlighting installation is largely dependent upon the facilities for installation, and it is thought that a few illustrations of actual schemes, with a few comments on the method adopted of installing the units, would not be out of place.

**Example (a).**—Where the area to be lighted stands well back from the road it is sometimes possible to arrange the floodlight units in the foreground. In such instances there is considerable choice available in the type of equipment. Fig. 23 shows the floodlighting of such a frontage. The building was 80 feet high and consisted of dark stone and stood back 30 feet from the railings. The building itself was isolated from its fellows, and the installation gives a delightfully pleasing result. In this instance nine 1,000-watt floodlights of the asymmetric type were installed just inside the railings.

**Example (b).**—It is sometimes possible to illuminate the building by means of projectors fixed on a canopy or veranda. In one instance the building was 65 feet long, of white stone, and was illuminated by three projectors placed at the outer edge of the balcony. In cases of this sort the balcony should certainly project from the building a reasonable distance compared with the height of the building, say a minimum of 8 to 12 feet, to obtain satisfactory results.

**Example (c).**—In the case of buildings having no courtyard or balcony two alternatives are available. One is to fit brackets to the building face itself. In such a case the minimum projection should be 3 ft. 6 in., but even then streaky results are almost certain to ensue unless the units are sufficiently close together. The architect usually requires the floodlights to be concealed, and in one instance floodlights were nested in imitation decorative foliage. The other alternative is to install the floodlight units on neighbouring buildings across the road or on lamp standards in the vicinity. The former is usually the only alternative for lighting

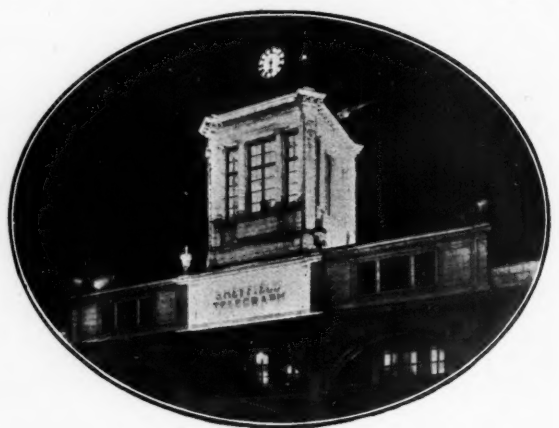


FIG. 24.

large buildings, when a considerable number of floodlights are used. In such instances it is essential to eliminate glare by employing spill shields on all floodlights that are not mounted out of the line of vision of the public.

**Example (d).**—This example shows the lighting of a tower for commercial purposes. It was found possible to fix the projectors for lighting three sides of a tower on the flat roof of the main building, while the remaining side was lighted from across the road. The throw of the floodlight on to the roof was only 18 feet, while that from across the road was approximately 100 feet. Due to the wide adjustment that was possible with the floodlights used, the same type could be installed in each position. The area of the side of the tower lighted was 20 by 20 feet. Fig. 24 shows the pleasing appearance of this installation.

**Example (e).**—Occasionally a basement area in front of the building aids the installation of floodlight projectors. In one such instance the floodlights were provided with projector lamps, and the angle-type units

themselves installed on brackets fixed to the outer wall of the area, the light being directed effectively on to the façade of the building itself. (See Fig. 25.)

Fig. 26 shows an interesting example of asymmetric lighting of a War Memorial at Sunderland. The column is 61 feet high by 13 feet diameter, and the intensity



FIG. 25.—Units installed in area.

over the central portion is 12 foot-candles. The floodlighting units are built into large spherical globes at the top of four lighting columns in the vicinity of the War Memorial, and each mirror reflector is 40 cms. diameter, and is provided with a 500-watt projector lamp. The efficient distribution of the illumination is brought about by the use of spreading glasses, which direct the light up and down the column.

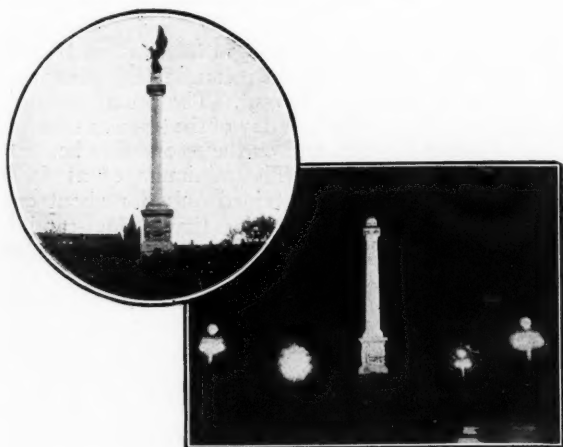


FIG. 26.—Floodlighted Memorial.

The floods themselves are 22 feet from the ground, and no glare is experienced in the vicinity. The memorial stands in an isolated position, and can be seen from a distance of  $1\frac{1}{2}$  miles.

### The Lighting of the Home

We notice in *l'Electricien* an article by M. Wetzel on the above subject, which shows that engineers in France are trying to inculcate the main principles of successful domestic lighting. Illustrations showing the lighting of a reading-room, dining-room and bedroom are included, and pictures of various special appliances are shown. In the main the recommendations are in line with those that would find favour in this country, stress being laid on the avoidance of glare by the general adoption of lamps with opal or obscured bulbs, and on making full use of the flexibility of electric lighting. Allusion is made to some of the special fittings exhibited at the Exposition des Arts Decoratifs last year, notably the ingenious arrangement of a mirror equipped with a border of diffusing glass lighted from behind.

### The Speed of Reading in Trains and Buses

It is common knowledge that reading a newspaper in a train or bus is usually more fatiguing than in one's home—the chief explanation offered being that the paper is usually in a state of vibration, even though in a smooth-running vehicle one may not be aware of the trembling. It has been suggested that this fact renders the provision of good illumination in trains, trams and buses even more important than in rooms. Some light on this point is shed by a series of researches recently undertaken in the Lighting Research Laboratory at Nela Park. Sixteen observers were asked to read two pages of printed matter which were fastened to a vibrating mechanism, the movements of which closely approximated to those encountered in moving trains. The time required to read a given amount of matter was recorded for both stationary and vibrating conditions, under varying conditions of illumination. The results were plotted in diagrams connecting the time required for reading and the illumination in foot-candles. The interesting fact was then noted that the curve for the vibrating reading matter was throughout higher than that for the stationary type—in other words a higher illumination is required to read a given amount of type in a certain time if the paper is vibrating instead of stationary. This conclusion is important, because it suggests that the effect of vibration may be largely overcome by a higher illumination—that, in short, the higher the illumination provided the less is the slowing-down effect of vibration in vehicles.

### Speed and Light\*

Each generation thinks of itself as wiser, better, and above all, speedier than the preceding generations. The ox cart, the stage coach, the railroad, the automobile are separated by short steps, each a bare generation long. The drone of the airplane is in the air, and the next step is evidently going to be a hop.

Different natural phenomena proceed at different rates with respect to time and space. As an example, take the case of an automobile travelling at 20 miles an hour when its headlights reveal an obstruction 100 feet away. If he hold constant speed, the driver has 3.4 seconds in which to recognize the obstruction and avoid it, or if he decides to stop he has plenty of time to come to an easy full stop. Let us assume that one second is taken for recognition and decision. Then there remain 70 feet for braking or other action. The same car and driver at 60 miles an hour have an entirely different problem. The single second taken for recognition and decision would bring the car within 12 feet or within one-seventh of a second of the obstruction, and it is obvious that safety at this speed demands a recognition distance of far more than 100 feet.

Assume it to be 200 feet, and there remains 112 feet for braking. But where 70 feet is ample for deceleration from 20 miles an hour, possibly 200 feet would be required for a full stop from 60 miles an hour. The obstruction must therefore be first brought into view at 312 feet, with no margin of safety for momentary inattention or wrong decisions. To produce equal visibility by means of an automobile headlight would require at 312 feet ten times the intensity that served at 100 feet.

Let us assume for the moment that the more intense beam has been produced as desired, then the real difficulties appear, for this more intense beam must be more studiously planned and more precisely formed to illuminate the field of vision, and above all it must be more accurately controlled to prevent it from producing a glare for the approaching drivers.

The aeroplane presents even more troublesome problems to the illuminating engineer. The speed rises to two or three times that of a racing automobile, and there enters an entirely new factor, that of elevation. Thus there are six directions that present elements of danger, and but little time is available for observation and the avoidance of making any one of the multiplicity of wrong decisions. Thus, when the air lanes become crowded we shall recall the good old days when life was simple and 60 miles an hour was speeding.

\* Abstracted from *The General Electric Review* (U.S.A.).

## The Relation Between Illumination and Efficiency in Fine Work (Typesetting by Hand)\*

By H. C. WESTON, M.J. Inst., E., and A. K. TAYLOR, M.I.E.E., A.M.I.C.E.

**Introduction.**—In the prefatory note to this report reference is made to the reports of the Departmental (Home Office) Committee on Factory Lighting, and to the schedule of "fine" and "very fine" processes given therein, with tentative suggestions as to the minimum illumination required. In these reports the need for more precise knowledge of the conditions of illumination desirable on physiological and psychological grounds was strongly emphasized. The Illumination Research Committee was accordingly requested by the Home Office to undertake researches in this field. After full consideration, the committee decided to select hand-composing in letterpress printing as the first example of fine work to be studied. The experiments were undertaken by Mr. H. C. Weston, of the Industrial Fatigue Research Board, and Mr. A. K. Taylor, of the National Physical Laboratory. Further, in order to ensure adequate technical criticism the Joint Industrial Council for the Printing and Allied Trades was approached and agreed to nominate Mr. A. E. Goodwin and Mr. A. E. Holmes to join a special sub-committee appointed to supervise the investigation.

The main conclusion to be drawn from the investigation is that output does not reach its maximum daylight value (and errors in turned letters their minimum value) until an artificial illumination of the order of 20 foot-candles is attained, which, so far as can be ascertained, is a very much higher illumination than that usually found in printing offices at present.

An increase in illumination *per se* appears, however, to be open to the risk of discomfort to the compositor, arising from glare or from heat from the source, and the most suitable method of attaining this illumination without such inconvenience is now under investigation. The special thanks of the Board and the Committee are due to Messrs. Kelly's Directories Ltd. for permitting the experiment to be carried out at their printing works.

**Summary of Researches.**—In the detailed account of this investigation it is pointed out that the rate of output may be affected, not only by the amount of light provided, but by other conditions of lighting such as glare, diffusion, shadow and contrast. In this investigation the amount of illumination provided has been changed without altering the system of lighting employed, so that the results only refer to the effects of adequacy (i.e., sufficiency) of illumination. In all experiments the method of direct lighting was employed, the value of illumination being altered by varying the size of lamps used and the mounting height. Gasfilled lamps were used, and care was taken to arrange their position and height so that the angle of cut-off was greater than 30°. In the first experiment the lamps were mounted in ordinary conical reflectors, but in subsequent experiments Industrial Reflector Fitting No. 1 was used, and the spacing so arranged that considerable uniformity of illumination was secured over the whole area of work.

The experiments were made under actual working conditions in a small composing-room occupied during each test only by the two compositors used as subjects. The work done consisted of continuous setting for commercial directories, the copy being constant in character and composed of "books" of directory slips printed in six point (nonpareil) type with ink-written corrections. The type set by the compositors was also six point and, as the pieces were not new, no complaints of glare from the type were received. The illumination

was measured at seven selected points on the composing frames, and the mean value, together with the ratio of maximum to minimum, is given in Table I.

In order to avoid week-end effects, all the tests, with the exception of the first, were made on Tuesday and Wednesday—the first test was made on Wednesday and Thursday. The hours worked were from 9 a.m. to 12-30 p.m. and from 1-30 p.m. to 5 p.m., the output of the compositors being measured at half-hourly intervals. The results obtained show that, generally, the output rate was rather greater on the second day of each test than on the first.

In addition to measuring the output a careful record was made of the number of mistakes, so that the qualitative as well as the quantitative effect of various values of illumination could be determined. Further, a separate record was made of the number of turned letters set, since this affords one of the best indications of the adequacy of illumination, the presence of turned letters being mainly due to the compositor's inability to see the "nicks" in the type.

In order to provide a standard for comparison a daylight test was made, and the rate of output during this experiment has been regarded as the normal, from which the efficiency of the several values of artificial illumination tried has been calculated. During the daylight test the illumination was measured at half-hourly intervals.

The frames at which the daylight test was made were illuminated by roof lights, the mean daylight factor at the two frames being 7.5 per cent. The actual daylight illumination range on the first day of the test was between 43 and 266 foot-candles, and on the second day between 21 and 495 foot-candles. The minimum of 21 foot-candles was, however, maintained only for about one hour, the illumination being not less than 50 foot-candles during practically the whole of the remaining time on both days.

TABLE I.

Test No.	Mean Illumination F.C.	Max. Min. (Uniformity)	Average Hourly Output (Ens) †	Per cent. of Daylight Output	M.V. × 100 En (Variability) ‡	Errors Er × 100 En §	Turned Letters T × 100 Er
1	1.3	1.60	1,232	76.0	6.55	1.41	24.00
2	6.8	1.30	1,433	88.4	6.68	0.79	17.56
3	14.0	1.37	1,510	93.7	7.32	0.69	12.51
4*	13.0	1.42	1,567	96.7	3.96	0.74	12.30
5	24.5	1.30	1,634	100.8	2.67	0.62	11.28
6	Daylight	—	1,621	100.0	4.09	0.61	10.48

\* Artificial daylight lamps.

† The En is the unit of measurement employed in printing. It is the width of the letter "n," which is the average width of the various pieces of type used. Thus, if the length of a line of type of any particular size is known, the number of ens per line or pieces of type set can be found by dividing the length of the line by the width of the "n."

$\frac{M.V. \times 100}{En}$  = The mean variation of output above or below the average, expressed as a percentage of the average hourly output. This shows the degree of variability of output experienced throughout each test period during which the illumination intensity was constant.

$\frac{Er \times 100}{En}$  = The average number of errors per hour expressed as a percentage of the average hourly output.

$\frac{T \times 100}{Er}$  = The average number of turned letters set per hour expressed as a percentage of the average hourly number of errors.

‡ The mean of these values, i.e., 20 foot-candles, corresponds with the optimum value tentatively suggested as the result of previous experiments with hand compositors.

\* Joint Report of the Industrial Fatigue Research Board and the Illumination Research Committee (issued under the auspices of the Medical Research Council and the Department of Scientific and Industrial Research); printed and published by His Majesty's Stationery Office, Kingsway, London, W.C., from whom copies, price 6d net, may be obtained: abstracted.

The results of the investigation are summarized in Table 1. The values of artificial illumination range from 1.3 to 24.5 foot-candles, while, at the latter value, the rate of output and the ratio of total errors to output reach the daylight value. The percentage of turned letters steadily diminishes as the illumination is increased, and closely approaches the normal at 24.5 foot-candles. In the original report curves are plotted (to a logarithmic scale of illumination), showing the relation between the illumination and output, total errors and turned letters. The results are so consistent that they justify the definite conclusion that the optimum value of illumination for hand composing lies between 15 and 25 foot-candles.

The expression "optimum illumination" as used here means that value of illumination at which it is possible for compositors easily to attain their maximum rate of output. This does not mean that maximum physiological acuity of vision is secured at this illumination, but it obviously implies that adequate occupational acuity of vision is ensured.

One point of interest is that in certain tests in which artificial daylight was used an increase of 3 per cent. in output was found, and unless this increase is purely a chance variation, it must be regarded as due in part to the colour of the light. However, the figures relating to total errors and turned letters did not confirm this effect, and the opinions of the compositors were also not in favour of the daylight lamps, as they "made the type look as if it had been dipped in Stephen's ink." Too much importance should not, however, be attached to these opinions, since it is hardly likely that the compositors would become sufficiently accustomed to the colour-difference in two days to enable them to appreciate any real merit it may possess. Whilst, therefore, no definite conclusion can be drawn as to the advantage or disadvantage of daylight lamps, the results do not affect the consistency of the conclusions of the investigation as a whole.

*Effects of Adaptation and Fatigue.*—Another interesting fact brought out by these experiments was the effect of adaptation. Whenever a significant change is made in conditions of work some time usually elapses before maximum production is reached under the new conditions. It has been found, for instance, that when the daily change from natural to artificial illumination is made during the winter months the rate of production falls at first and does not reach a normal value for about an hour. In the present experiments a similar effect has been observed, the output being as a rule greater on the second day than on the first day of the test.

Incidentally the investigation also illustrates the effects of fatigue. Inadequate illumination may be expected not only to diminish the rate of production, but also to increase the fatigue experienced by the worker. This is shown to be the case by data showing the diurnal variation of output and errors for each compositor. The maximum fatigue was naturally experienced when the minimum illumination was provided. In the case of subject "A" there is no quantitative evidence of fatigue except at the minimum illumination, but the quality of his work, as judged by the ratio of errors to output, suffers until the illumination is raised to 24.5 foot-candles. The results for subject "B" indicate the presence of fatigue at practically all values of illumination. In the original paper the variations of output throughout the day have been plotted for each test. The rise in the general level as the illumination increases is evident. There appear to be natural fluctuations in efficiency which are not accounted for by any variations in work, and are independent of illumination. The opinions of the compositors themselves were very definite on the question of fatigue during the first test when the illumination was only 1.3 foot-candles, and it was difficult to induce them to continue the experiment on the second day. At other values of illumination, however, they did not complain of fatigue, though they did not like working continuously under artificial light. When the illumination was raised to 24.5 foot-candles they remarked that it was too glaring to be comfortable. It has been already stated, however, that all direct glare was avoided, and the compositors' remarks really refer

to the vague sense of oppression which seems to be induced by the nearness of a powerful light source, even when the light from the source, if it enters the eye at all, does so only at a very acute angle.

*Conclusions.*—The data presented here point very definitely to the existence of an optimum value of illumination for hand composing, which is of the order of 20 foot-candles. With such a value, provided by a well-planned installation designed to secure approximate uniformity of illumination over the whole area of work, it may be expected that the daylight rate of output will be maintained, at any rate, for the short periods which normally require the use of artificial light during the winter months.

The interests of employer and worker alike are seriously affected by inadequate lighting of composing rooms. If the illumination is less than 2 foot-candles, nearly one-quarter of the possible output is lost, while the number of mistakes is more than doubled, and the fatigue experienced by the compositors is materially increased. Even when the illumination is as much as 7 foot-candles—a value which is probably higher than the present general practice—over 10 per cent. of the possible output is lost and there is an unnecessarily high percentage of errors.

There is some possibility that the use of daylight lamps for lighting composing-rooms may be advantageous though, owing to the relatively low efficiency of these lamps, the determination of this point is perhaps of more scientific than practical interest at present.

If work is done in artificial light only for a few hours a day, there is no evidence that any undue ocular fatigue is likely to result, providing the illumination is uniform and of the order of 10 foot-candles. The provision of higher values of illumination is largely an economic question, which the results of this investigation show to be well worthy of consideration. If work has to be done continuously in artificial light, as in newspaper offices, the provision of higher values of illumination appears to be essential, if the efficiency of a night shift is to approach that of a day shift.

## Experiments with the New Coolidge Cathode-Ray Tube

Much interest has been excited in scientific circles by the new cathode-ray tube devised by Dr. W. D. Coolidge, who is associated with the research laboratory of the General Electric Company of America. The cathode-ray tube, like radium, is constantly bombarding high-speed electrons into space, but at a rate that is strictly under control and at a considerably lower average velocity. The rays can, however, be highly concentrated and many striking experiments can be performed with them. Crystals of the mineral calcite glow with an intense orange light when exposed to these rays, and this glow of "cold light" will continue for hours. Granite, a mixture of various minerals, glows with varied colours; some very fugitive, but others persisting for some time after exposure. Ordinary salt is turned a brown colour and castor oil is solidified. One of the most interesting and curious results of applying the rays is the formation of a new yellow compound in acetylene gas. This compound is highly insoluble, and a use may be found for it as a protective material for metals. The effect of the rays on living tissues is very marked; exposure of a tenth of a second caused temporary loss of hair on the ear of a rabbit, and an exposure of one minute caused a scab to form, and ultimately a hole in the ear. When the tube is operated in a darkened room it appears to be surrounded by a ball of purplish haze, which attains about two feet in diameter with a pressure of 350,000 volts. This is ascribed to the ionization of the air. The new tube thus offers many interesting possibilities, and there are doubtless many effects still to be discovered and investigated.

## Proceedings at the Public Safety Congress Organized by the National "Safety First" Association\*

THE proceedings at the above congress, held in London during October 26th—27th, have now been published in pamphlet form. At the first session a paper entitled "Traffic Prevention in Relation to Legislative Administrative Action" was read by Mr. J. S. Pool Godsell (Ministry of Transport). After referring to tests of vehicles and drivers the author made some reference to the problem of dazzling headlights, outlining the work done by the Ministry of Transport committee in this field. Much valuable work has been done by lamp designers and inventors, but attention is drawn to the necessity for correct focussing and maintenance of such lamps, which are liable to get out of order, and adjustment during running conditions. Mr. Godsell also referred with approval to the practice of switching off headlights to avoid dazzle when meeting another car. This has been the subject of much controversy, but it is considered that the balance of opinion is strongly in favour of the practice. Another highly controversial subject touched upon was the use of rear lights on bicycles. At the present time pedal cyclists are not required to carry either a rear red light or a "reflex" lens or any other device, and this is regarded as a source of accidents. The cyclists' organizations object to any such requirements, and there are numerous practical and administrative difficulties. The matter is so controversial that it can only be settled by Parliament.

Another paper, by Mr. H. E. Aldington, on "Road Construction" was also read. Special interest attaches to the suggestions for methods of avoiding interference with the line of vision of drivers, and the use of a centre island equipped with a beacon light, together with illuminated direction notices, at the intersections of highways. Considerable attention is also devoted in this paper to the question of providing safe crossing places for pedestrians, and to methods of encouraging them to make use of subways. The Westminster City Council has recently erected an illuminated sign advising people to make use of the subway, but this does not appear to have had very much effect! The system of using luminous traffic signals in American cities is described, but the problem is not so simple in London, where the streets are not laid out on any rectangular plan. Experiments with luminous signals are, however, being made in Piccadilly, three alternative lights (amber for "get ready," green for "go," and red for "stop") being used. Three-colour signals are also being adopted in Berkeley Street, Albemarle Street, Dover Street and other thoroughfares, all designed to assist co-ordinated control from one central point. In the discussion, Councillor Dr. A. H. Wright emphasized the great importance of illuminated signs and sign-posts, and Mr. Grice referred to the important question of the lighting of arterial roads. In many cases local councils are not prepared to find the money for efficient lighting, and he suggested that the Ministry of Transport might assist the Councils in this matter.

At the delegates' luncheon the proceedings were quite informal, but a short address was delivered by the Home Secretary, who referred to the valuable work done by the "Safety First" movement. Delegates were afterwards conveyed to the London General Omnibus Company depot at Chiswick, where they saw a practical demonstration of the training of bus drivers and a "safety first" film. During the congress a considerable number of prizes and certificates in connection with the essay competition for schoolchildren was awarded in the Kingsway Hall.

In the second session an instructive paper entitled "Traffic Accident Prevention by Education at Home and Abroad, with Particular Reference to Work in Schools" was read by Captain J. W. Moore. This

contained a series of diagrams showing the progressive increase in the number of street accidents during recent years. A specially striking point was the illustration, side by side, of the continuous decrease in the accident rate in the works of Messrs. Thomas Firth & Sons, of Sheffield, and the steady increase in the number of street accidents during the period 1918—1925. In a subsequent diagram, similar figures for London and the provinces were tabulated; this diagram shows that although the actual number of accidents has increased progressively in London, the rate of increase is less than in the provinces, which is doubtless to be attributed to the influence of the "safety first" work done in the metropolis. Some valuable data relating to developments in other countries are contained in a series of appendices. At the end of the booklet is a summary of communicated remarks. Amongst other suggestions we note that of Brigadier-General Sir H. C. L. Holden that insufficiency of road illumination is responsible for more accidents than an excess. It was suggested that pedestrians should wear a light overcoat at night so as to render them more readily visible. Mr. A. Elsdon Martin recommended that stationary lights visible from the roadway should be deflected downwards, thus obviating dazzle of street lamps shining horizontally on a wet windscreen; a minimum depression of 15° would amply illuminate the surface of the road and economize the unwanted upward and horizontal rays.

## British Engineering Standards Association

### ANNUAL REPORT.

The Chairman's statement, presented at the recent eighth annual general meeting of the British Engineering Standards Association, and now reprinted, reveals a remarkable record of work, which has expanded considerably during the past year. During the year 41 new and revised specifications, including 34 general and 7 aircraft specifications, have been issued. The number of B.E.S.A. publications sold during the year amounted to 58,351 copies, and there are now no less than 499 committees of various kinds, the work of which is undertaken by 2,407 honorary members. We venture to think that there are few professions which could point to such a volume of valuable honorary work as this. In reviewing progress during the year attention is drawn to standardization in connection with illumination as a special feature. Two specifications dealing with portable photometers and industrial reflector fittings have been issued by the illumination section, and also a glossary of terms and definitions used in illumination and photometry. (It will be recalled that these specifications were reviewed before a meeting of the Illuminating Engineering Society early last year.) Illuminating engineering, it is remarked, is a comparatively new field of endeavour, and very little experimental data is so far available. The Association is much indebted to the Department of Scientific and Industrial Research, and other organizations for aid in experimental work. The hope is expressed that in the future the gas industry will support the efforts of the Association to a greater extent.

There can be no question of the immense value of the work that the B.E.S.A. is doing, and it is to be regretted that financially the past year again showed a deficit. The coal strike and the dislocation of industry has, no doubt, added to the difficulties of the position. We sincerely hope that in the future the Association will receive the generous support that it deserves.

\* Price 2s. 6d. Published by the National "Safety First" Association, 119, Victoria Street, London.

## POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—  
Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

### Electrically Lighted Shop Facias

WITH recent innovations in shop design considerable sums of money are now expended on elaborate and often beautiful facias, but unlike the shop window the value of the facia is almost entirely restricted to daylight hours. The facia has two main functions to perform; in the first place it must impress upon the minds of all who pass by the name of the shop it represents, while in the second place it should act as a reminder to those who already patronize the store. As an ideal it should, therefore, operate as long as there are people in the street to see it, and must be on duty by day as well as by night. It is little wonder, therefore, that the more progressive shopkeepers have endeavoured to make their name visible equally during day and night. Indeed, where a lighted facia is available, it often has a greater value at night-time than during the day, since it so much more readily stands out from its surroundings after dark.

An illuminated facia must be designed as though it were an ordinary electric sign from the point of view of visibility and engineering details, but, in addition, requires much more artistic treatment. It is the purpose of these notes to show one or two simple methods which can be employed, and which cannot fail to make a shop facia more attractive and have a wider appeal.



FIG. 1.

In the past the illuminated facia has closely followed the conventional block sign in structure and design, which in daytime presents an unsightly appearance altogether out of keeping with the rest of the shop. Furthermore, the exposed lamps of this type of letter or of the channel letter at night-time appear too garish and lessen the attractiveness of the window display itself. An illuminated facia must harmonize with the furnishing and general atmosphere of the shop.

Usually facia signs can be roughly divided into the following classes, although a number of further subdivisions are possible:—

1. The letters themselves are lighted up.
2. The letters appear dark against a light background. These are usually known as "silhouette signs."

The first of these is essentially a box sign in which the lamps are installed behind sheets of opal glass and the letters themselves cut out of sheet metal. When the

sign is alight the letters stand out white against a black background. Such a sign is dependent upon the contrast between letters and the background, and the distance of visibility is obviously not so great as that obtained from

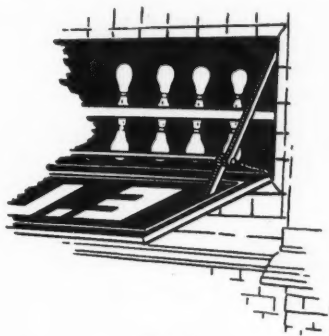


FIG. 2.

an ordinary bare lamp sign, but is sufficiently bright to prove attractive and effective. Such a sign is illustrated in Fig. 1. The lamps should be installed immediately behind the letters, and better results are obtained when opal or white sprayed lamps are used, since a more uniform distribution of the light is obtained. For large



FIG. 3.

letters two rows of lamps are required to avoid patchiness. To facilitate cleaning such signs it is a good plan for the front to be hinged in a similar manner to that indicated in Fig. 2.

In the silhouette sign, the letters themselves invariably stand out black or very dark against a brightly lighted



FIG. 4.

background. Such signs are now made in a variety of designs, which are shown in Figs. 3, 4, 5 and 6. Fig. 3 illustrates a box type of sign similar in construction to that in Fig. 2, but the letters are painted on white opal glass, the lamps again being behind the glass front.

Each of these signs suffers from the disadvantage of requiring a reasonable depth to accommodate the lamps, and with many shop fronts such a depth is impossible, and other methods have to be employed. In Fig. 4



FIG. 5.

letters of either metal or wood are fixed to a white background, and give a daylight appearance similar to that of an ordinary fascia. At night-time, however, lamps at the top of the sign flood the white background, and the letters appear dark against this light background. Unfortunately, if the letters are somewhat large, a patchy result is obtained. To mitigate this difficulty in larger signs lamps are installed in a frame which completely surrounds the sign (see Fig. 5). The troughs which surround the frame can either be painted white, or, in some cases, may be mirror-lined to obtained as accurate a control of the light as possible. Fig. 6



FIG. 6.

illustrates yet another type of silhouette sign, which is particularly suitable for large letters. The letters themselves are channelled out at the back and supported from the background by means of extension pins. Lamps are installed in the channel at the back of the letter, and when operating flood the background with light. The channels are often painted white in order to reflect as much light as possible on the fascia background. The size of the letters and their distance apart determine the length of the extension pins. An example of this type of sign is to be found at the petrol-filling station near the Olympia and at Muswell Hill.

### Street Lighting in Chicago

According to a note in the *Transactions* of the Illuminating Engineering Society (U.S.A.) the new system of lighting recently initiated in State Street, Chicago, is considered to give the highest intensity of illumination in existence. The street is 3,150 feet long, and 70 standards, each supporting two 2,000-watt lamps in rippled glass globes, mounted 30 feet above the roadway, have been installed. The new installation cost \$100,000. The street receives approximately 2,000 lumens per linear foot. This compares with 822 lumens per foot in the recent Salt Lake City installation, and 750 lumens per foot in San Francisco. It is interesting to observe that the new system was officially inaugurated by President Coolidge, by pressing a button at the White House. We may fairly regard this as an indication of the importance attached to public lighting in the United States.

### Secrets of the Selling Art

The lecture on the above subject by Mr. G. S. Francis at the third of the E.D.A. Conferences led to an interesting discussion. On the whole the remarks of various speakers endorsed the view expressed by Mr. Gaster—that the first essential of a good salesman is to find out what the public wanted, to study their troubles and to gain their confidence. Mr. Edwards agreed that any attempt to foist on a buyer what he did not want was to invite the door to be closed in one's face in the future. He considered that the essentials of successful salesmanship were: (1) a real technical knowledge of the articles offered, (2) tact in dealing with customers, and (3) persistence. Mr. Hayes also remarked that failures were often due to inability to understand the purchaser, his personality and temperament, and Mr. Jones pointed out that the purchaser had also duties—successful salesmanship depends on the power of someone else to buy. Mr. Francis, in replying to the discussion, remarked that there were some people who were born salesmen, and they did not need this discussion. Much could, however, be done by training.

One may doubt, nevertheless, whether even a "born salesman" can sell technical material such as electrical products unless he fully understands them. It is here that the Continental method of giving salesmen a thoroughly sound preliminary technical training bears fruit.

### Decorative Electric Lighting


A paper entitled "Lighting as a Decorative Art" was read by Mr. W. G. Raffé at a conference held in Newcastle-on-Tyne on December 8th. The conference was arranged under the auspices of the North-East Coast Area Sub-Committee, Miss C. Haslett presiding.

In his remarks Mr. Raffé laid special stress on the use of colour in decorative lighting. The first part of the address was devoted mainly to an explanation of the chief characteristics of colour, namely, hue, tone and saturation. The appearance of objects depended very greatly on the choice of coloured light. As an example the author mentioned the undesirable effect of a somewhat yellowish light on the appearance of linen. He suggested that artificial light should be recognized as necessarily something different from daylight, and natural lighting conditions should not be copied too exactly. The use of colour in artificial lighting had great possibilities. The lighting of the home was usually quite inadequate. Mr. Raffé suggested that one of the main inducements to people to spend their evenings in theatres, music halls and restaurants was the brighter lighting and the use of colour to produce attractive effects. A portion of the expenditure thus incurred might well be devoted to improving the lighting of the home. No proprietor could afford to dispense with colour as an integral part of the lighting of a restaurant. Colour was one of the most important elements in stage lighting, and was now being applied, as a supplement to ordinary lighting, in the illumination of shop windows.

In the course of the discussion it was suggested that ballroom lighting should be carried out in warm tones in winter, so as to produce an impression of heat, whilst in summer daylight lamps would give a sense of coolness.

### Shop-Window Lighting on Sunday

An interesting new departure has been the lighting-up of shop windows on Sundays. Oxford Street on a Sunday evening has been conspicuous in this respect—the lighted windows attracting much attention and serving as an excellent preliminary to the January sales. The illumination certainly brightens the street at a time when its appearance is ordinarily quiet, and the greater freedom from traffic on Sunday enables people to get a better view of the windows than on a week-day. It will be interesting to see how far the practice of "Sunday lighting-up" of shop windows extends.



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# Tennis Court Lighting at Tunbridge Wells

REAL tennis, as most of us know, is one of the oldest ball games in the world. It still has many enthusiastic adherents, and a distinct revival would seem to be imminent, if we may judge of the activities of a number of those who are bringing so much to bear on re-establishing it as a national game.

One of those prominently interested in the game is Capt. MacLean, whose enthusiasm is patent to all who visit his famous court at Rusthall House, Tunbridge Wells. This court was first designed in 1884, since when it has been redesigned and altered several times.

House, Kingsway, W.C.2., and was carried out by Messrs. Fredk. Hayden Ltd., electrical contractors, of 35, High Street, Tunbridge Wells. To permit easy access to the reflectors and the lamps a special gangway was constructed above the ceiling.

The system of artificial illumination employed allows of an average uniform intensity of light of the order of 25 foot-candles as against an average daylight intensity of approximately 53 foot-candles at floor level. Illumination by artificial light resulted in a maximum reading of 28.6 foot-candles, and a minimum of 18.3 foot-candles, the readings being taken from 65 different points of the court. The daylight readings similarly taken were: Maximum 91.8, minimum 23.1 foot-candles, showing a disparity in light intensity of as much as



FIG. 1.—Rusthall Court by artificial illumination.

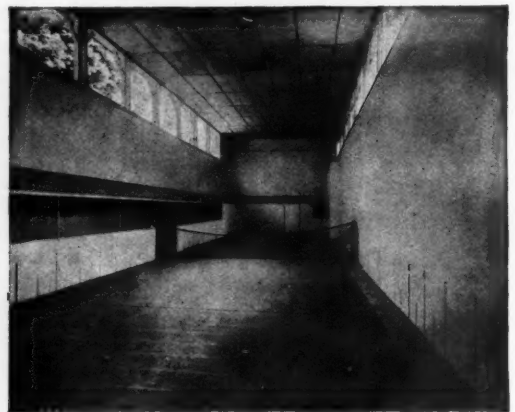


FIG. 2.—Rusthall Court by daylight.

In order that play might be possible at any hour, a special series of tests was carried out with a view to a permanent electrical installation, and it was decided to install twelve 1,000-watt Osram gasfilled lamps in the ceiling. These were mounted in special dispersive reflectors, and shielded so that players when facing the net would not be affected or confused by the brightness of the inner edge of the reflector. The scheme was designed by the General Electric Co. Ltd., of Magnet

68.7 foot-candles between one part of the court and another, while the greatest disparity in illumination by artificial light was only 10.3 foot-candles. These readings are shown in Fig. 3.

A black court renders it essential that the ball should be evenly lighted, whereas with a white court an even light on all surfaces is required, and special lighting for the dedans, and generally for the galleries. Capt. MacLean has no hesitation in expressing his belief that

TEST		ARTIFICIAL LIGHT		DAYLIGHT	
MAXIMUM	ILLUMINATION	28.6	FOOT CANDLES	91.8	FOOT CANDLES
MINIMUM	"	18.3	"	23.1	"
AVERAGE	"	25.08	"	53.75	"
DIVERSITY	RATIO	MAX: MIN = 1.56 : 1		MAX: MIN = 3.9 : 1	

ARTIFICIAL LIGHT										DAYLIGHT	
POSITION	INTENSITY	POSITION	INTENSITY	POSITION	INTENSITY	POSITION	INTENSITY	POSITION	INTENSITY	POSITION	INTENSITY
1	24.0	11	26.5	27	21.7	40	24.0	53	29.0	7	33.4
2	22.7	12	26.5	28	25.1	41	22.2	54	27.3	8	49.6
3	25.1	13	22.3	29	27.4	42	22.7	55	25.1	9	46.7
4	22.7	14	26.4	30	26.5	43	27.4	56	25.1	10	50.1
5	25.1	15	20.3	31	24.0	44	26.2	57	28.5	11	51.0
6	27.4	16	20.3	32	21.7	45	25.1	58	27.0	12	55.0
7	26.5	17	21.4	33	22.6	46	22.7	59	26.6	13	45.6
8	27.4	18	27.9	34	25.1	47	25.1	60	27.3	14	51.0
9	26.5	19	27.4	35	25.1	48	27.0	61	25.1	15	53.9
10	22.7	20	22.7	36	19.4	49	27.0	62	26.1	16	53.1
11	22.7	21	21.2	37	21.7	50	16.5	63	27.1	17	57.1
12	26.4	22	21.7	38	22.7	51	20.5	64	25.5	18	39.0
13	26.4	23	20.0	39	25.1	52	15.1	65	20.5	19	..

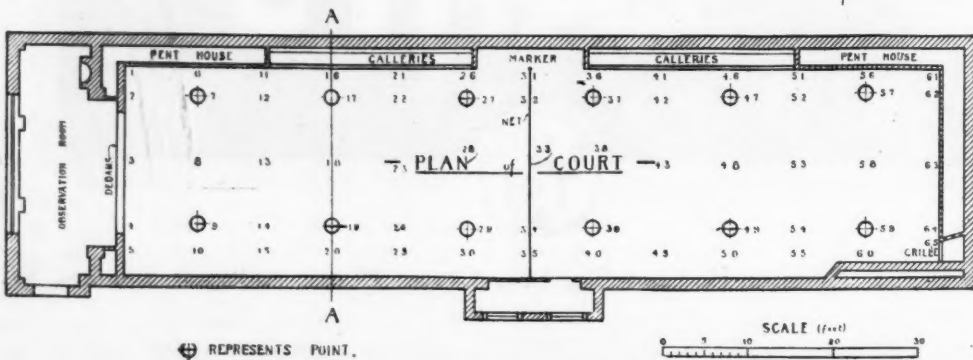
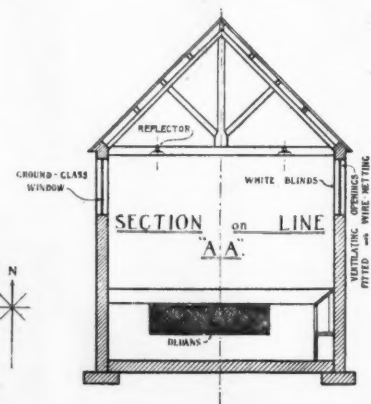


FIG. 3.—Showing readings by artificial illumination and by daylight.

the white court with its even lighting on all surfaces is preferable. That such a court lends itself to satisfactory artificial illumination is shown by our photograph of Rusthall Court (Fig. 1), taken solely by the court lighting. On comparison of the daylight view (Fig. 2) with the illuminated view, it is at once apparent that there is a great difference in the intensity of lighting, not only at floor level where the readings were taken but on the penthouses, galleries, side and end walls.

Rusthall Court is a typical owner's court on which, in the interests of the game, smaller courts might profitably be modelled. There is an observation room built behind the dedans, and a professionals' room near by. These would not, however, be needed in the case of a small owner's court or club, and equipment and maintenance expenses would be reduced to really small proportions.

### Standardizing Window Demonstrations

The ingenuity shown by American supply undertakings in designing attractive window demonstrations to encourage better lighting is illustrated by an account of the methods of the Carolina Power and Light Co., summarized in a recent issue of *The Electrical World*. The method adopted is to decide on special appropriate displays, and then circulate detailed instructions so that it can be reproduced in all the offices of the concern—in this case thirty in number.

In a room suitable for, photographic purposes the advertising manager designs and modifies displays until exactly the desired effect is produced. The actual set-up is then photographed, and copies, accompanied by full verbal instructions, are sent out to all the local offices. In this way the simultaneous broadcasting of an idea is secured, and the effect is correspondingly impressive.

In one case mentioned the motto round which the display was built up was: "Public utility service places conveniences in the home that kings in their castles could not command." The display utilizes a crown on a cushion as the central object, flanked by an assembly of modern lamps and other domestic contrivances. The instructions contain suggestions for the make-up of the crown, composed of cardboard coated with gold leaf. Under this is a purple cushion. A purple shield with gold design forms a background to the crown, on which the spotlight is focussed, window-lighting units being equipped with purple screens.

The emphasis of some "slogan" like this, which appeals to the imagination, is good advertising. New displays are sent out each week, so that public interest is not allowed to slacken.

### Gas and Electricity—Friendly Relations

I am pleased to see that gas and electricity supply engineers show signs of putting aside that attitude of mutual antagonism, at times suggestive of personal hatred, which has in times past characterized their relationships, and are beginning to realize that, in the sphere of generation at all events, co-operation is a vital necessity, if the fuel resources of the nation are to be utilized in an economical and scientific fashion. Reference to this necessity was made at the annual meeting of the Institution of Gas Engineers, held recently, and at this meeting M. C. P. Sparks particularly urged gas and electricity supply engineers to know each other better. In the sphere of distribution it is all to the good that a spirit of healthy competition should be maintained; good for the consumer, and equally good for

the engineer, as providing the stimulus for improvement, and supplying the corrective against the tendency to get into a rut. The effect of this competition is seen in the great improvements that have been effected in the domestic applications of gas that have taken place contemporarily with the development of electricity supply. There is no reason, however, why this competition should not be of a friendly character, or why the gas and electricity experts should forget that they are brother engineers. However firmly rooted may be the faith of the electrical man in the superiority of his system for domestic uses, he should never forget the benefits conferred on the working-class house by the gas industry. The gas cooker has been an undoubted boon to the poor housewife, and has been to her a convenience of incalculable value. Even if it is to be displaced by the electric cooker, recognition of the industry which perfected the intermediate if imperfect device must not be withheld.

—Electricity.

### Sheffield Illumination Society

The annual General Meeting of the Sheffield Illumination Society was held on December 16th in the Council Room at the Montgomery Hall, Sheffield, the following officers being elected for session 1927: Hon. President, Mr. J. F. Colquhoun; President, Mr. H. Lazenby; Vice-President, Mr. J. R. Hall; Hon. Treasurer, Mr. G. Sayer; Hon. Secretary, Mr. E. Marrison; Auditor, Mr. E. Wilson. Committee: Mr. Horace Twigg, Mr. W. Brookfield, junr., Mr. J. Watkinson, Mr. H. Sanderson, Mr. A. Nadin, Mr. H. Allsop, Mr. Herbert Twigg, Mr. R. Allen, and Mr. J. Carr.

### Lamplough Glass Electric Bulbs

It may not be generally known that the filament of the electric gasfilled lamp emits an appreciable amount of ultra-violet light. Under ordinary circumstances such radiation is practically completely absorbed by the usual form of glass bulb. If, however, a glass that is relatively transparent to ultra-violet rays is used we have a source that may have considerable possibilities for therapeutic treatment. The new "Vitaglass" developed by Mr. F. E. Lamplough has the property of transmitting all but the very short wavelengths, and its use for hospitals, sanatoria, etc., has accordingly been recommended in order that inmates may get the maximum advantage of ultra-violet rays in sunlight. Bulbs for gasfilled lamps composed of this glass have now also been introduced. From a reference in *The British Journal of Actinotherapy* we understand that the first lamp of this type utilizes 300 watts, but a 150-watt type equipped with the ordinary bayonet holder is contemplated, and other sizes will be introduced as required. The Lamplough bulb does not emit rays of very short wavelength, and the exposure may therefore be relatively prolonged; patients may, for instance, sleep under the lamps with the body exposed. Moreover, in view of the absence of the very short waves, protective goggles are not necessary, though naturally precautions should be taken against glare from the visual rays. It is stated that a couple of these lamps were installed experimentally at the Zoo some time ago, and have yielded useful results.

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## A Half-Century of Artificial Lighting\*

By M. LUCKIESH

THE past fifty years has witnessed practically all the developments in electric lighting. A half-century ago only a few factories were using arc lamps. In 1876 homes were lighted by candles, oil lamps, and flat-flame gas jets. Two years later it was reported in the newspapers that Edison had succeeded in inventing an incandescent lamp and "subdividing" the current so that every householder could have electric light where and when he wanted. The reports were, however, premature, for the carbon incandescent lamp was not a practical success until three years later.

It is interesting to read the comments made at that time. Hippolyte Fontaine, in an article in *The Revue Industrielle*, in 1878, discussed Edison's carbon-filament lamp, and ended his discussion thus:—

"Now, if anyone wishes to know what we think of this affair, we will tell him that the journalistic scribes have no object beyond that of preparing for the creation of a company with a fabulous capital, which company will never, to the end of eternity, pay a dividend to its shareholders."

Fifty years ago not a single home was wired for electricity, and only a few factories were wired. At the beginning of 1926 more than 50 per cent. of homes in the United States were wired for electrical service. The lamps used in the average home represent a demand of nearly one kilowatt. Industry in the United States is at present 65 per cent. electrified. Last year there were sold in the United States 278,600,000 large incandescent lamps, 123,000,000 automobile lamps, 30,000,000 flashlight lamps, and 43,000,000 Christmas-tree lamps, a total of nearly half a billion lamps of all sizes.

During these fifty years many different forms of electric lamps have been introduced. The low-pressure discharge tube at one time appeared a promising development. But this type is now chiefly confined to very small units, used mainly as indicators, and to certain applications for display lighting. Recent developments, however, seem destined to return it to certain specialized fields, as it can now be made in units consuming less than one watt.

From the time of its introduction the incandescent lamp has been improved by leaps and bounds. The arc lamp has also received much attention and attained a high degree of usefulness, especially for street lighting, though even here it is being largely replaced by incandescent lamps. It will, however, probably retain its supremacy as the illuminant for searchlights for some time, owing to the very great concentration of light, which renders possible such enormous beam-candle-powers. The mercury-vapour lamp is also used to some extent in the industries.

For general lighting purposes, however, the electric incandescent lamp has outstripped all other forms. The electric filament has won its fifty years' battle owing to (1) its divisibility into almost any desired size, (2) the possibility of shaping the filament so that advantage can be taken of optical principles in the design of lighting equipment, (3) the enclosure of the filament in a glass bulb, which makes it possible to operate the light source with safety almost anywhere, (4) the relatively great progress in the efficiency of light production, and (5) the simplicity of the electric incandescent lamp as compared with other sources.

A contrast is drawn between the efficiency of Edison's early carbon lamps, yielding about 1.3 lumens per watt, and that of the modern tungsten (gasfilled) 60-watt lamp which operates at 11.1 lumens per watt. Some of the larger lamps even yield an efficiency twice that mentioned above. The average lumens per watt of all lamps sold in 1907 was 3.5; in 1925 it was 12.5 lumens per watt.

The cost of light from tungsten-filament lamps to-day is only a small fraction of the cost fifty years ago. The

average efficiency of all filament lamps sold in the United States during 1926 will be approximately ten times that of the early carbon lamps. Another effect of the increased efficiency is the possibility it affords of obtaining coloured light on a scale impracticable in the past; daylight can be imitated with great accuracy, and almost any shade of colour is now obtainable.

Artificial light turns night into day. We can look ahead and visualize the possibility of a 24-hour industrial day—such as we have, in fact, for long had on the railways. A two-day shift is in existence in many factories, and helps materially to reduce costs of production. Many tests have shown that increased illumination has resulted in improved production. In offices and factories where 15 years ago an illumination of 3–4 foot-candles represented the best practice, values of 10 to 20 foot-candles are now in use. Good lighting also decreases spoilage of materials, decreases accidents, preserves eyesight and makes us healthier and happier.

Whereas there was little or no illumination of streets fifty years ago, most of our important streets are now illuminated, and the lighting is being steadily improved. Fifty years ago, light in the theatre was used chiefly to reveal the action on the stage, but now, in many cases, the lighting effects form a great part of the entertainment. Picture palaces depend on our modern illuminants. Altogether we owe a great deal of our progress to the improvements in electrical illumination during the last fifty years.

## Mass Production in the Lighting Industry

At a recent conference in Frankfurt the possibilities of mass production were discussed, about 400 directors, factory managers, officials and others being present. In the narrow sense this term ("*Fließarbeit*") is understood to be continuous production on a moving band, as applied to the making of the Ford motor-cars, the speed of travel naturally depending on the process. But in a wide sense the term is used for any process of duplication designed to produce articles in large quantities. F. Wenzel, in referring to this discussion, raises the question whether mass production can be more fully applied to the lighting industry. He believes that in many directions there is room for improvement in Germany, mentioning a visit to a lamp factory where everything was done in a now obsolete way—parts being carried by hand from one part of a room to another, and even from story to story. Great progress is constantly being made in speeding up the processes of lamp manufacture, some of the automatic machinery being wonderfully designed and delicate in operation. It remains to be seen whether lamps could be turned out on a strictly moving band method, each operation being done to time on an endless chain without a pause! The author hints that in various directions Germany can learn a great deal from other countries, including America. The introduction of mass manufacture, however, is only half the task. Similar methods must be applied to the disposal of articles and it is chiefly here that the lighting industry can learn from methods abroad, i.e., in methods of stimulating interest in lighting and creating a need by the public for better illumination and improved lighting appliances.

## Better Lighting

AN ADDRESS AT THE HARROGATE ROTARY CLUB.

At a recent weekly luncheon of the Harrogate Rotary Club, Mr. L. M. Tye, who is associated with Holophane Ltd., gave an address on Illuminating Engineering, in which attention was drawn to many improvements initiated during recent years. Reference was made to the important investigations undertaken by the Home Office Departmental Committee on Lighting in Factories and Workshops, and to the advantages of concealed lighting, as illustrated especially by the lighting of the stage of a theatre. This method has recently been adopted with advantage in the lighting of various cathedrals and churches.

\* Abstract of a contribution to "Industrial and Engineering Chemistry."



Fig. 1.—Assistant fitters attending a lecture during their training before examination to qualify for promotion.

## “Watson House”

### The New Workshops, Laboratories and Stores of the Gas Light and Coke Company

SINCE 1901, when the Gas Light and Coke Company first instituted a system of training boy apprentices who entered their employ from school, the area of the Company's supply and the amount of their business has increased enormously. The inauguration, on November 17th, of new training shops, laboratories and stores in the magnificent building which used to be Messrs. Crosse and Blackwell's factory at Nine Elms, Battersea, shows that the Company's system of scientific and technical training has kept pace with their progress in manufacture and distribution.

#### The New Building

Several of the Company's departments have been transferred to the new quarters. The recent amalgamation with Brentford Gas Company made this necessary, and Watson House, possessing an excellent river frontage, and being close to the goods yards of Nine Elms and Vauxhall, is admirably situated for a central store. The fact that the new premises are the stores centre of the Company's works, distribution and sales departments, means that all work which the apprentices do in the repairing, finishing, fitting and testing shops is of direct service to the Company. In fact, the tools and stores used by the fitters and their assistants in the sales department are inspected and tested by the apprentices, under supervision, as part of their course.

#### The Apprenticeship Scheme

This alone means that the boys have a definite status as employees of the Company; at the same time con-

tinuing their general education in English, Science and Mathematics, under the direction of the London County Council. The opening of the new foundation by Sir George Hume, Chairman of the London County Council, shows that vocational training of this sort in co-operation with the schemes of local authorities plays a definite part in the general national education. In his speech at the opening ceremony, Sir George Hume remarked that much criticism was heard to-day of the methods of education and of the results of those methods. It was pointed out as a sign of failure that boys leaving the elementary schools at the age of 14 did not come up to the standard required of them in industry. But, said Sir George Hume, if the great public schools were to turn out their boys at the same age, subject them to similar home influences, and allow them to run free for six months, the result would be no better. In spite of the efforts of education authorities, there was still an unfortunate hiatus between the standard of the boy leaving school and that required of him in industry.

It is this gap which the apprenticeship scheme attempts to bridge.

#### THE TRAINING COURSES.

In the new building training will be given to three classes of employee—boys of 14 or 15, boys of 17 or 18, and fitters. Under the main scheme, fifty or sixty boys of 14 or 15 are each year started as fitter apprentices on a five or six years' course of technical training combined with the general education given at the Westminster Technical Institute.



Fig. 2.—Apprentices testing gas supply pipes.



Fig. 3.—Apprentices at work in the smith's shop.

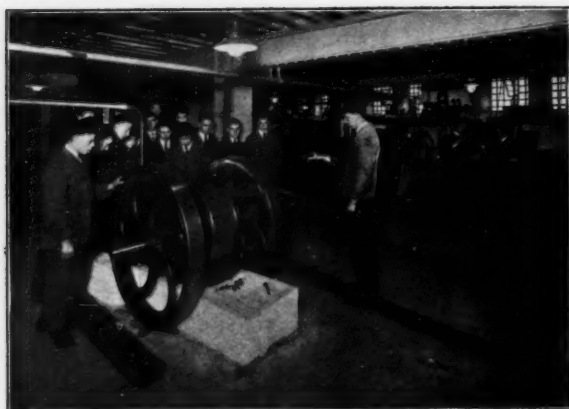


FIG. 4.—Apprentices being taught the principles of gas engine construction.

The practical training, which is carried out in the machine shop, the smith's shop and the carpentry shop at Watson House, is divided into "years." First year apprentices learn carpentry, and the importance of accuracy and the proper care of tools. They take up floor boards, run pipes, cut joists; gain experience, in fact, of all the more elementary tasks with which they will later come in contact on the district as fitters' mates.

In their second year, the apprentices are given more advanced work in the brazing and repair shops. They gain a practical knowledge of the various types of lamps, fires, cookers and water heaters, etc., which they put together and repair themselves.

In their third year the apprentices go out into the districts to work as fitters' mates.

During their fourth year apprentices are brought in again from the district. Some of them act for a time as foremen's clerks. Some of them work in the office, where they assist the clerk of the district and gain a practical insight into office routine. Every apprentice, besides, spends part of his time in the showrooms.

#### GENERAL EDUCATION.

Industrial training too often neglects general education, but as Mr. Milne Watson, Governor of the Company and an acknowledged authority on educational matters,



FIG. 5.—General view of a machine shop where apprentices are instructed.

said when the building which is named after him was opened, there is no more common cause of complaint than the fitter who cannot express himself clearly both in speech and writing. He should, for example, be able to write a legible and intelligible report; otherwise he becomes a source of expense.

Moreover, education for vocation carries with it education for leisure. Without profitably occupied leisure an employee cannot take an intelligent interest in his work. The spirit of keenness and ambition is the best earnest of efficiency which an employer can hope for.

#### OLDER PUPILS AND FITTERS.

Pupils of 17 to 18 years of age are each year started on a more advanced course in the work of the department. At the Westminster Technical Institute they study for the Diploma in Gas Supply of the Institution of Gas Engineers, and in the laboratories, shops and demonstration room at Watson House they undertake more advanced work. To overcome the difficulty in coping with rush periods, there are also intensive courses given to gas fitters who are not in the regular employment of the Company.

#### THE GAS INDUSTRY'S SCHEME.

Mention has been made of the Diploma of the Institution of Gas Engineers. The apprenticeship scheme of

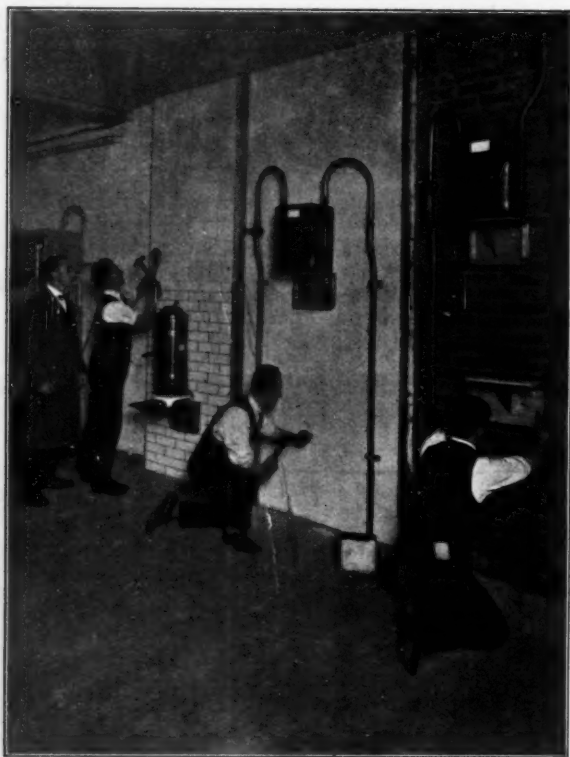


FIG. 6.—A training test for fitters. Meter shelf and geyser fixing on various surfaces.

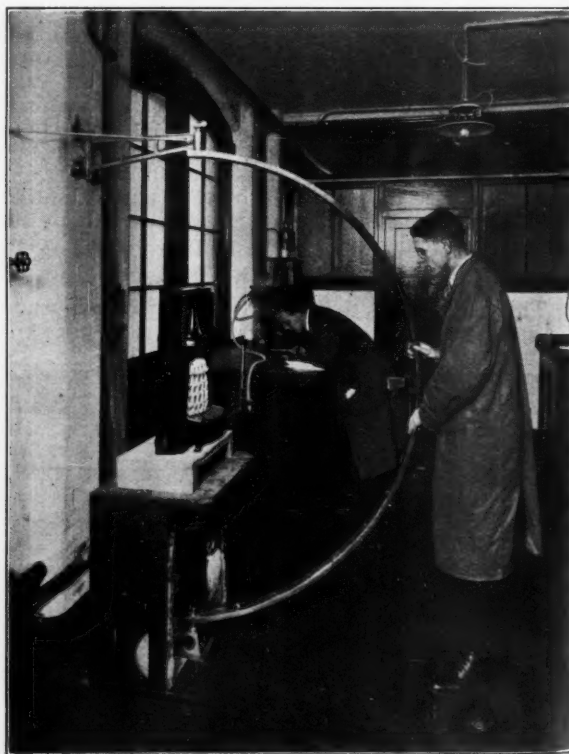


FIG. 7.—The modern method of accurately testing the radiant efficiency of a gas fire.



FIG. 8.—The truck-repairing shop. The Company make all their own handcarts.

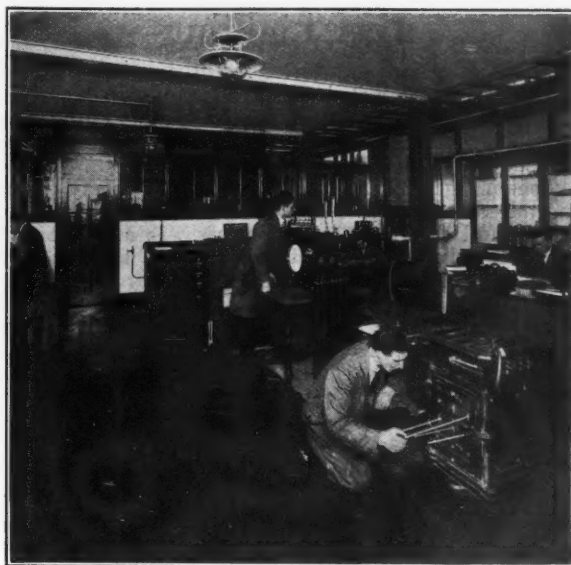


FIG. 9.—Testing the efficiency of the oven of a gas cooker at all points.

the Gas Light and Coke Company is much older than the Institution's scheme for adult employees; but the two are linked up with a system of education throughout the gas industry which is gradually being perfected and has already been a most striking success. This national scheme has been worked out under the auspices of the Board of Education. It is in a form which takes full advantage of all existing educational facilities, and it can be taken up by undertakings in every area.

#### THE VALUE OF TRAINING.

The provision of good service to the public depends on the man quite as much as on the machine. Manufacture and distribution may be brought to the highest possible pitch of efficiency; but in any industry the final criterion must always be the human factor. A faulty fitting will not always cause complaint; a dense fitter may be a source of irritation to a consumer which, indirectly, will do incalculable harm to goodwill.

#### THE REAL ENDEAVOUR.

The educated workman or salesman will preserve intact the existing public demand for the service which

he represents. That is his merely negative value; he does not disturb the consumer's confidence. But he is vital to the success of a more positive aim—the amelioration and ultimate dissolution of the smoke evil. Upon him, in the long run, depends all the spade work of convincing the consumer. Publicity and legislation can only prepare the way for the man who goes into the home or the factory to say what gas can do—the salesman; and no less important, the man upon whom the proof of it depends—the fitter. They must themselves believe in their cause, and they can only do so by developing an attitude of mind and an orderliness of thought which can command the wider issues implied in the word "service."

At Watson House there are now 143 boys who have been given this opportunity. Since 1901, 468 apprentices have been trained by the Company. Of these, 57 obtained responsible positions on the supervisory staff, and nine became teachers of gas supply in the Technical Institutes attended by their fellow employees. So much success has already greeted a far-sighted enterprise which may be confidently expected to fulfil great hopes in the future.

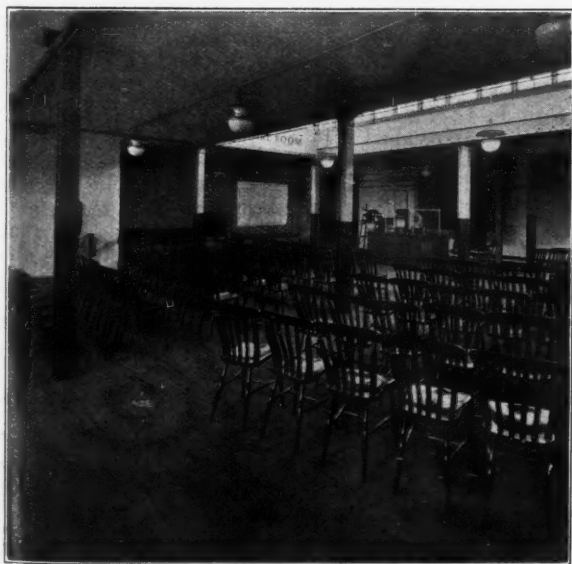


FIG. 10.—The lecture room, lighted with Sugg's "Bon Marché" pendants. With their large enamelled reflectors they are ideal for high rooms.



FIG. 11.—One section of the stores. Rows of gas lamps ready to cope with the great demand for gas lighting in streets, factories, shops and private houses.

## Gas Lighting

IN the course of an address recently delivered before the Society of British Industries,\* Mr. F. J. Gould, Chairman of the Council, gave a summary of the early developments in gas lighting, referring to such steps as the successive improvements in flat-flame burners, the Wenham regenerative burner, and the discovery of the incandescent mantle. The introduction of the more robust and efficient inverted burner was an important step, but the adoption of superheating subsequently likewise led to a great advance. To illustrate this, Mr. Gould presented polar curves of light distribution for some of the latest types. An ordinary universal burner consuming 4 cubic feet of gas per hour would give 120 candles, i.e., about 30 candles under standard conditions as regards nature of gas (say 500 B.Th.U.) and pressure (30 tenths). If to the same burner a superheater, to which three bijou mantles are fixed, is attached, the result would be 200 candles, or 50 candles per cubic foot of gas consumed per hour.

Present methods of operating inverted burners from a distance leave much to be desired. The most popular is the pneumatic switch and valve unit. There are also other well-known devices such as Sugg's automatic lighter; but all necessitate the use of a by-pass flame. If some means of automatic lighting which did not involve the use of the by-pass could be evolved this would be a great aid to gas lighting. It was possible that the last had not been heard of the action of gas on platinum sponge. The difficulty was that the platinum was quickly oxidized. Overcome this and the problem of distance lighting is solved!

Turning to street lighting, Mr. Gould quoted some figure recently presented by Mr. Haydn T. Harrison, showing that there were 5676 miles of streets lighted by 100,078 gas lamps, and 2392 miles of streets lighted by 70,616 electric lamps. It was noticeable that, even in places where there was municipal electric lighting, 73 per cent. of the street lighting was carried out by gas. Insufficient attention has been devoted to lantern design. Mr. Gould pointed out the importance of the polar curve. "We get brightly lighted patches and then a stretch of gloom. We need to get down to the problem, like our electrical friends, of decreasing the diversity factor. The new type of street lamps with reflecting mirrors set at scientific angles, and which prevent glare, and give the fullest diffusion of light, are economical and efficient, and mark another step of progress in this section."

In the next section of the paper, dealing with Gas Lighting and Health, Mr. Gould referred mainly to the ventilating effects of well-designed gas lighting systems, and also presented a table of intrinsic brilliancies in order to illustrate the necessity of shading the electric filament. Reference was made to a recent paper by Mr. Keable containing statements from many authorities on this point.

Mr. Gould next quoted figures recently presented by Mr. W. J. Sandeman and Mr. W. A. Bishop relating to efficiencies of burners and the range of illumination requisite for various purposes. In particular, he drew attention to the need for standardizing efficiency ratings, and suggested the practice of expressing the efficiencies of gas burners in terms of British Thermal Units per candle-power-hour (mean hemispherical rating). He also emphasized the necessity for standardizing reflector design, and thus deriving regular spacing rules—a point that was illustrated by curves presented for typical Holophane reflectors used with gas lamps.

The following data for customary allocations of light for different types of interiors were suggested:—

	Candle-power per sq. ft.
For sufficient light for simple operations ...	0.4 — 0.6
For medium lighting ...	0.5 — 0.75
For bright lighting ...	0.75 — 1.0
For very bright lighting ...	1.0 — 1.5

Generally speaking, Mr. Gould continued, gas was barely holding its own in the race for supremacy between

gas and electricity. The modern houses built under the Government housing scheme are in most cases gas lighted. In this field gas has obvious opportunities. He wished, however, to emphasize the necessity for further effort. "I have heard quite a number of people in recent times express the opinion that gas lighting is a doomed industry, and some men in the industry itself are taking the loss of the lighting as a foregone conclusion. Without vision, nations perish—so it is with industries. Our own, at the present time, needs to exercise wisely the gift of 'long vision.' There is a section which, building too much security upon retaining as a monopoly the future cooking and heating, is in danger of holding too loosely the lighting load at present in its grasp. It is true that at the moment gas holds these fields with no small margin in its favour; but surely no thinking gas engineers can sit down quietly and allow the lighting business to slip away because of its apparent security. As men of science, they must give our friends the electrical engineers credit for making every effort in the future to reduce, or even in time reverse, the margin of security which we at present cherish as our own. Some new method, perhaps some new element, may be discovered; so rapid are the strides being made that we may awake one fine morning to find our cooking and heating business in much keener competition than is at present the case. Therefore, exercising vision to the fullest extent, we should hold on to every section of our existing business, remembering that lighting may again be a vital plank in our schemes for the future. Why should we let this section drift from our grasp?"

In conclusion, Mr. Gould contended that much of this totally unnecessary loss of lighting business is due to sheer apathy. "If we are to be defeated in the lighting branch of our business, then let it be fighting in the last ditch. Only by such a spirit shall we prove ourselves worthy to retain the custody of the remaining branches of our public service."

The President (Lord Ednam) having thanked Mr. Gould for his address, the discussion was opened by Mr. Goodenough who said that in his experience most of them were fighting quite tenaciously for their lighting business. It was perfectly true that there was a very large field for gas lighting still to be retained and obtained—particularly with regard to housing schemes. He quite agreed that it would be the height of folly for the gas industry to throw up its hands and say that the days of gas lighting were over.

Mr. J. Wilfrid Drake contended that one thing necessary in order to enable them to carry on their competition with electricity was an absolute calorific standard of gas. Fluctuations in calorific power greatly upset the functions of the burner. If pressure varied, there was naturally also a great difference in volume as delivered to the appliance. He strongly urged that, if possible, not only a constant calorific value but a standard value to which everybody could work, should be provided.

Mr. F. C. Tilley, in proposing a vote of thanks to Mr. Gould, recalled that in 1818 his own firm had fitted up flat flame gas burners in the first church that was lighted by gas in London—St. Mary's, Haggerston. Since that time they had been for five generations continuously engaged in gas lighting. He agreed that a complete system of distance control was one of the means by which gas lighting could be retained. It was a difficult problem, but there was no reason why it should not be solved. He also hoped that the aim of adopting a standard quality of gas would be persevered in. He believed that the views held as to the future of gas lighting were now much more enthusiastic than was the case five or six years ago.

Professor Arthur Smithells, in seconding the vote of thanks, suggested that the increased information now available as to the part played by catalysis might be helpful in solving the problem of distance lighting.

Mr. Gould, in acknowledging the vote, again insisted on the necessity for preservation of the lighting load, though he believed that the engineers who were indifferent to this problem were only a minority.

\* *The Gas Journal*, Nov. 17th, 1926, pp. 425-430.

## Antique Wood Electric Fittings

By A Correspondent

**W**HILST great progress has been made in the design of metal fittings during recent years, there has been a notable growth of interest in fittings constructed of wood. This has been the case both in this country and abroad. It was remarked, for instance, that at the Leipzig Fair this year wooden moulded candlesticks, table lamps, standards and pendant fittings formed a larger proportion of the exhibits than ever before.

may be used almost exclusively for conversation and repose, and accordingly a very bright illumination may not be desired. Very bright lighting might be "out of the picture"—inconsistent with the antique surroundings, and stimulating rather than sedative. Even from the standpoint of revealing old furniture and decorations it has been urged that a high illumination is often not desired—that the objects are best seen somewhat indistinctly, emerging from semi-obscurity similar to that in which they would actually have been used in the past.

It will be seen, therefore, that we have here a distinctive outlook on illumination, which has to be taken into consideration and ought really to be included in



FIG. 1.—A charming lantern in wood, with diffusing-glass panes.



FIG. 2.—A tasteful table lamp, with wooden stand and base.



FIG. 3.—Electric fitting finished in wood, which may be ornamented in colour and gilt.

This type of fitting may be seen in great profusion at the showrooms of Messrs. Woodfyt Sales Ltd., in Diana Place, to which the writer recently paid a visit. The three illustrations supplied by this firm are typical of the pleasing effects produced with such fittings of wood. Practically any distinctive style can be reproduced—the only exception, we believe, being some of the fittings in the Dutch style. It seems impracticable to reproduce the thin curved parts of many of these chandeliers in wood, and probably this particular type is best executed in metal.

We understand that decorative fittings in wood are becoming very popular; for example in the houses of eminent architects. In such cases exact faithfulness to old designs is often desirable; it is, in fact, possible to imitate the old work so exactly that it is almost impossible for the greatest expert to tell the original from the reproduction. But even in modern country houses which are constructed on the "antique" plan fittings of dark wood are very popular; for example, for porch lights one even finds lanterns hung from a wooden pole and cross-piece, such as not infrequently carried the old horn lanterns of bygone days.

Whether it is desirable thus to seek to perpetuate conditions of the past is a point which would give scope for an interesting discussion. Some contend that in using modern electric light the imitation of designs and conditions developed in the days of oil lamps and candles is a retrograde step. However this may be, the existence of a taste for these old things remains. Indeed the bustle of modern life seems to have encouraged the liking for such methods and the cultivation of a sense of repose. One finds here an idea which is quite distinct from the ordinary conception of illuminating engineering, presupposing high illuminations and insisting on the cultivation of the greatest efficiency in the use of light. When a room is planned on antique lines it is often intended as a picture rather than an interior in which reading and writing, etc., are undertaken. It

the scope of illuminating engineering. In the design of antique fittings charm of appearance is everything: the fact that the efficiency of the appliance is relatively low may go for very little. Certainly many of the wooden fittings to be seen at these showrooms are in themselves very pleasing objects. The main principle that one would wish to have observed in their design, however, is that if a new illuminant, such as an electric lamp, is used with an old design, the incongruity should not be forced upon one's notice. For this reason it is agreed that if electric candles are used with old-time designs of chandeliers, the filament should invariably be concealed by conical silk shades; similarly the glass of antique patterns should surely be of a diffusing character, so that the filament of the lamp within cannot be distinguished.

One good feature of much of the lighting of antique interiors is that *soft* light is usually considered essential; the shading is, in fact, often much more complete than in a room lighted by purely modern methods, and the eye only sees surfaces of very moderate brightness. It is probably this circumstance that enables quite weak illuminations to be more effective than would be anticipated.

On the other hand, there are certain styles, the French period for example, which seem to be associated with a certain amount of glitter. Chandeliers of prismatic glass and fittings comprising an assembly of lustres, giving rise to a pronounced sparkle, are in frequent demand. The writer has always considered that these devices are essentially unscientific and inartistic; many fittings designers agree that this is so. But the demand for them persists, and this fact, like the imitation of the antique, has to be reckoned with. Firms acting as decorators have always recognised these mental characteristics of their customers. Those concerned with illuminating engineering would also do well to study the point of view, and see how far it can be reconciled with the claims of efficiency.

## TRADE NOTES & ANNOUNCEMENTS

### NERON LAMPS: THE ADVANTAGES OF STANDARDIZATION.

At a meeting of the Sub-Committee of the Business Research Committee, which was held in connection with the visit of the Dominion Premiers, it was stated that as a result of the standardization in the iron and steel industries the cost of production had been decreased 5s. a ton for all sections rolled. It was further estimated that the value of stocks of ironmongery in the hands of wholesalers and retailers of Great Britain amounted to £25,000,000, and that if the number of types was reduced to a moderate extent one-fifth of the capital thus locked up could be released.

In the same way the value of stocks of electric lamps outside factories was stated to approach £4,000,000, and it was said that the ultimate effect of the unification and standardization of voltages may cut this amount down by at least half. But is it necessary to have to await the standardization of voltages throughout the country, or, in other words, the completion of the national electrification scheme, which may take a period of several years, when there are so many unnecessary types and shapes of lamps upon the market which could be eliminated without delay? After all, it is a recognized fact that a large number of types of lamps are by no means the most efficient of their kind, but are made merely because some consumer at one time or another has asked for them. It is for the trade to educate the users in the right direction.

It is interesting in this connection to note that Messrs. Neron Lamps Ltd. placed on the market some time ago a standard line of electric lamps which they claim to be suitable for all ordinary lighting purposes. This standard line of lamps, containing only five types, replaces 42 types of lamps manufactured in the past. By adopting this standardization it follows that the quantity of lamps necessary for resellers' stocks is reduced by more than 50 per cent.

The Neron standard line of lamps is manufactured by the largest electric lamp works in Europe, i.e., Osram, G.m.b.H. Komm, Berlin, who have specialized in the manufacture of electric lamps for more than 40 years and have acquired a high reputation for the class of their products. The types of lamps contained in the Neron standard line are similar to those adopted throughout the Continent and America, and we understand that they are giving every satisfaction to users of electric light, and at the same time keeping the resellers' stocks down to an absolute minimum. A careful inspection of the Neron catalogue would be well repaid.

### SHOP LIGHTING ON A FIVE YEARS' GUARANTEE.

This forms the title of an effective leaflet referring to the "Geocoray" system of shop-window lighting, issued by the General Electric Co. Ltd. Attention is drawn to the valuable qualities of these reflectors, which, besides being scientifically designed to ensure the direction of light where it is chiefly needed, are guaranteed not to check, peel or tarnish for five years. Suitable Osram gasfilled lamps are specified for each type of reflector. The system is easily installed and adapted to any existing structural contour, architectural features or types of window decoration, and to any size of window. The leaflet is illustrated by several effective pictures of windows, and reference is also made to the "Britalux" dust-proof interior-lighting units.

### SPLICES AND TAPES FOR RUBBER-INSULATED WIRES.

A booklet published by the Okonite Company (U.S.A.), (for whom Messrs. Wm. Geipel & Co. are sole agents for the United Kingdom), deals with the Okonite, Manson and Dundee insulating tapes for insulating and protecting joints of electric light and power cables. In an introduction the vital importance of the highest grade insulation and the securing of perfect joints is strongly emphasized, and the advantages of the tapes mentioned above are clearly set out.

### BENJAMIN NEWS.

A telegraphic communication, received just too late for insertion in our last issue, announced the successful issue of the action brought by Benjamin Electric Ltd. in regard to the familiar use of the temperature-registering device embodied above the radiators of motor cars.

We have also to acknowledge the receipt of the Christmas number of *The Benjamin Reflector*, attractively executed in colours. There are several photographs illustrating the use of Benjamin fittings in commerce and industry, and notes on the "Dim-a-lite" adaptor and other specialities. Other pages deal with gifts for the motorist, including the Boyce monometer, and with Benjamin wireless valves and components, all forming suitable Christmas gifts.

### ELECTRIC HEATING AT THE ZOO.

Some particulars furnished by the General Electric Co. Ltd. regarding the heating installation carried out by them at the Zoological Gardens suggest that the completed scheme will place the Zoo in a foremost position with regard to other similar institutions. Many special patterns of electric heaters designed for use in special positions have been designed, and the heaters in each case will be under automatic control. In the monkey-house the provision of "cosy corners" on cold days is a feature; similarly crocodiles will be able to swim in electrically heated water, crawl over electrically heated sand and lie on electrically heated rocks, and bask in electric light having affinity to tropical sunlight.

Much has been heard of the valuable influence of artificial daylight at the Zoo, but it should be recognized that the heating by which it is now supplemented is also a contributory element in enabling many animals which were formerly wont to perish during an English winter to be kept alive.

### GOLD MEDAL AND CERTIFICATE AWARDED FOR PHILIPS LAMPS.

Quality has always been an outstanding feature of Philips' products, which has again been fully demonstrated by the award of a gold medal and certificate for Philips Miners' Lamps at the recent Mining Exhibition held at Bucharest.

### CONTRACTS CLOSED.

The following contracts are announced:—

MESSRS. SIEMENS AND ENGLISH ELECTRIC LAMP CO. LTD.:  
*Admiralty*; for a large quantity of Siemens gasfilled, standard-vacuum and spiral-filament traction lamps.

*L.N.E. Rly. Co. (Southern Railway)*; for the supply of Siemens train-lighting lamps, gasfilled and vacuum, during the 12 months ending December 31st, 1927.

*Booth Steamship Co.*; for the supply of electric lamps during 12 months ending December 31st, 1927.

MESSRS. METRO-VICK SUPPLIES LTD.:

*Great Western Railway*; for "Cosmos" tungsten-filament lamps.

*Admiralty*; for "Cosmos" vacuum ordinary and traction type and gasfilled ordinary lamps.

*Parish of Lambeth, Board of Guardians*; for "Cosmos" vacuum metal-filament, gasfilled, and carbon lamps for a period of 12 months from January 1st, 1927.

GENERAL ELECTRIC CO. LTD.:

*Admiralty*; for 200,000 Osram gasfilled and vacuum-type lamps, and for 15,000 special Robertson carbon-filament lamps.

*Booth Steamship Co.*; 12 months' contract for Osram metal-filament, vacuum and gasfilled lamps, Group 1 and 2, and Robertson carbon-filament lamps.



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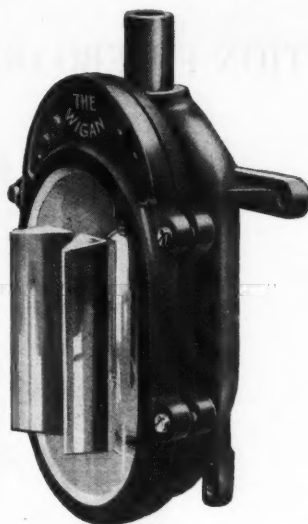


### HOME BRANCHES:

<b>BRIGHTON:</b> 35, Duke St. ('Phone: Brighton 5512).	<b>GLASGOW:</b> 23, Douglas St. ('Telegrams: "Starter, Glasgow." 'Phone: Central 1253).	<b>NEWCASTLE-ON-TYNE:</b> 27, Grey St. ('Telegrams: "Cryselco, Newcastle-on-Tyne." 'Phone: Central 1286).	<b>MANCHESTER:</b> Douglas Chambers, 63, Corporation St. ('Phone: City 9120).
<b>BIRMINGHAM:</b> 21 22, Newspaper Hse., 164, Corporation St. ('Phone: Central 3741).	<b>LONDON:</b> Thanet Hse., 231 2, Strand, W.C.2. ('Telegrams: "Cryselco, Strand, London." 'Phones: Central 3016/7/8).	<b>LEEDS:</b> 11, New Station St. ('Telegrams: "Cryselco, Leeds." 'Phone: Leeds 27866).	<b>CARDIFF:</b> 30, Charles Street. ('Phone: Cardiff 7466).

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#### THE FADE-OMETER.

We have several times been asked by readers to give particulars of the "Fade-ometer," which is an apparatus designed for testing the fastness of colours. It may be of interest, therefore, to refer to some data given in a recent description contained in a booklet available from Messrs. Kelvin, Bottomley & Baird Ltd., who are sole agents for the manufacturers (The Atlas Electric Devices Co., of Chicago).

Considerable difficulties have in the past attended tests of the fastness of colours, by reason of the extremely variable nature of daylight. In winter the period for which daylight is available is greatly shortened, especially in this country, where mists and fogs prevail, and it is to be noted that the violet and ultra-violet end of the spectrum, on which the fading power of sunlight largely depends, is even more affected by climatic conditions and period of the year than the brightness. This difficulty has led to a search for a constant artificial source of light, and it is claimed that by the aid of the Fade-ometer suitable tests of permanency may be made in a few hours' time.

The first point was obviously the selection of a suitable artificial source. The quartz-tube mercury-vapour lamp naturally suggested itself, on account of its richness in ultra-violet light and its quick-fading action. It appears, however, that the marked dissimilarity of its spectrum to that of sunlight is a drawback. Although fading takes place quickly, marked discrepancies occur in the behaviour of different coloured materials.

The source ultimately selected is a form of arc lamp. Its light appears to the eye somewhat violet compared with sunlight; it has, however, the essential property that in the violet and ultra-violet the spectrum resembles that of sunlight very closely. Experience shows that this source furnishes a good indication of the fading action of sunlight. In the case of dyed textiles it is stated to produce the same result as 1.3 hours of standard summer sunlight, and in the case of printed matter five hours. In making tests it is also desirable to imitate the temperature and humidity conditions characteristic of a summer day, and the apparatus is designed to furnish a temperature of 70° in the vicinity of the materials tested, and a humidity the same as that found in Chicago.

In the illustrations of the apparatus the samples are mounted on a drum, within which the arc is situated. The apparatus is of primary importance to the dyestuff and textile industry and to colour printers, but it can also be applied in many other directions, e.g., in ageing tests of rubber, paint and varnish, etc., all of which are affected by continuous exposure to sunshine.

#### THE NEW WESTINGHOUSE AUTOMATIC ARC WELDER.

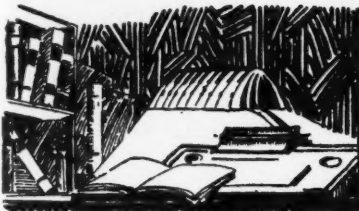
Recent developments in welding apparatus are illustrated by the new Westinghouse Auto-Arc, which is a machine for automatically feeding a continuous welding wire used in metallic electrode welding. The wire may be fed at any speed up to three feet per minute, which is necessary to maintain a constant arc length and constant arc voltage. This machine strikes the arc automatically, and will, if necessary, exert a pull of approximately 200 lbs. in order to prevent fusion of the electrode wire to the work.

This device relieves the operator of the exacting hand labour of maintaining the arc and feeding the welding wire, and results in a better weld and much quicker work. The apparatus is particularly useful in work requiring the welding of long, continuous seams, in repairing worn cross-heads and valve guides for locomotives, etc.

For such industries as automobile, shipbuilding, steel bridge building, car building, naval yards, tank car, oil tank building, metal sash manufacturing, and structural steel fabrication, the device has also many applications.

#### THE GUILD TRICHROMATIC COLORIMETER.

This useful apparatus is illustrated on a card issued by the makers, Messrs. Adam Hilger Ltd. The operation of the instrument is very simple, and enables the instrument to measure and specify the colour of any object with precision. The operator, on looking through the telescope, sees a coloured patch, the colour measured being in the top half, whilst below this area is a similar one consisting of the colour composed in the instrument. By adjustment the colours are brought into agreement and can be recorded in numerical terms.



REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

A PSYCHOLOGICAL STUDY OF INDIVIDUAL DIFFERENCES IN ACCIDENT RATES; by Eric Farmer and E. G. Chambers. (Report No. 38; issued by the Industrial Fatigue Research Board, and available from His Majesty's Stationery Office. Price 2s. 6d. net.)

It is recognized that the physical safeguarding of machinery and plant, however perfect, cannot reduce industrial accidents below a certain limit. Much depends on the human factor. Accidents may not be due entirely to "carelessness" or "ignorance." In particular there is evidence of a comparatively small but recognizable group of specially susceptible subjects. This report embodies the results of a preliminary attempt to devise means of detecting this abnormal susceptibility. Many forms of tests (Reaction Time, Dotting, Pursuit Meter, Ocular Muscle Balance, Intelligence, and other methods of trial) are described, and an effort is made to interpret the tests in relation to various factors, such as age. Much remains to be done, but the present inquiry suggests that it is already possible, in a rough way, to determine the probability of any person sustaining an undue number of accidents. Such knowledge would, one imagines, be valuable to insurance companies, and the report well deserves careful study.

English and Amateur Mechanics.—It is announced that the two weekly technical papers "English Mechanics, and The World of Science" (founded in 1865) and "The Amateur Mechanic and Work" (first published in 1887), have recently combined, and, with the issue for October 29th, will appear as a single but enlarged publication, at the old price, namely, 3d.

These weeklies have, to some extent, run on parallel lines in the past in catering for the craftsman, amateur mechanic and woodworker, and also those with scientific and other hobbies, including astronomy and microscopy; many benefits should therefore accrue to the present readers by this merging of interests. Advantage has been taken of the present opportunity to modernize the combined paper, and to present it in an attractive form. The new publication will appear under the title of *English and Amateur Mechanics*.

PHOTOMETRY

BY JOHN W. T. WALSH

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